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General Information

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NPN Silicon High Frequency Transistors

PNP Silicon Transistors

PNP Silicon High Frequency Transistors

Accessories

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Summary of NPN Transistors

AF transistors for high-quality AF and DC amplifiers

in metal case JEDEC TO-18

BC 109, 2 N 929, 2 N 930

in plastic case \approx TO-92

BC 173, BC 239, BC 413, BC 414,
BC 549, BC 550

AF general purpose transistors for switching and amplifier applications

in metal case JEDEC TO-18

BC 107, BC 108, BC 190, BCY 58, BCY 59,
BSW 82 . . . 85, 2 N 2221, 2 N 2221 A, 2 N 2222, 2 N 2222 A

in plastic case \approx TO-92

BC 170, BC 171, BC 172, BC 174, BC 237, BC 238, BC 337, BC 338,
BC 546 . . . BC 548

in metal case JEDEC TO-39

BC 340, BC 341, BSY 51 . . . 56, BSY 87, BSY 88, BSY 90,
2 N 1613, 2 N 1711, 2 N 1893, 2 N 2218, 2 N 2218 A, 2 N 2219, 2 N 2219 A

AF general purpose transistors for switching and amplifier applications at higher collector currents

in metal case JEDEC TO-39 with solid header

BC 140, BC 141, BSY 81 . . . 86

Switching transistors for high-speed switching applications

in metal case JEDEC TO-18

2 N 2368, 2 N 2369, 2 N 2369 A

Transistors with high collector emitter voltage for video amplifiers, Nixie-drivers and preamplifier to line output tubes in TV sets

in metal case JEDEC TO-18

BF 120, BSY 79

High frequency transistors for RF and IF amplifiers

in plastic case \approx TO-92

BF 198, BF 199, BF 240, BF 241

Summary of PNP Transistors

AF transistors for high-quality AF and DC amplifiers

in metal case JEDEC TO-18

BC 263, 2 N 3962, 2 N 3963, 2 N 3964

in plastic case \approx TO-92

BC 253, BC 309, BC 415, BC 416, BC 559, BC 560

AF general purpose transistors for switching and amplifier applications

in metal case JEDEC TO-18

BC 260, BC 261, BC 262, BC 266,
BCY 78, BCY 79, BSW 72 . . . 75,
2 N 2906, 2 N 2906 A, 2 N 2907, 2 N 2907 A

in plastic case \approx TO-92

BC 250, BC 251, BC 252, BC 256, BC 307, BC 308, BC 327, BC 328,
BC 556 . . . BC 558

in metal case JEDEC TO-39

BC 360, BC 361,
2 N 2904, 2 N 2904 A, 2 N 2905, 2 N 2905 A

AF general purpose transistors for switching and amplifier applications at higher collector currents

in metal case JEDEC TO-39 with solid header

BC 160, BC 161, 2 N 4030, 2 N 4031, 2 N 4032, 2 N 4033

High frequency transistors for RF and IF amplifiers

in plastic case \approx TO-92

BF 324, BF 424, BF 450, BF 451

Index of Symbols

b	Imaginary part of y -parameters
b_f	Imaginary part of forward transconductance y_f
b_i	Imaginary part of input admittance y_i
b_o	Imaginary part of output admittance y_o
b_r	Imaginary part of reverse transconductance y_r
B	Base connection
B_G	Imaginary part of generator (source) impedance
C	Capacitance; junction capacitance; collector connection
C_i	Input capacitance ($b_i/2 \pi f$)
C_o	Output capacitance ($b_o/2 \pi f$)
C_{CB0}	Collector base capacitance (open emitter)
C_{EB0}	Emitter base capacitance (open collector)
C_r	Feedback capacitance ($b_r/2 \pi f$)
E	Emitter connection
f	Frequency
f_T	Gain bandwidth product
F	Noise figure
F_c	Noise figure in mixer stages
g	Real part of y -parameters
g_f	Real part of forward transconductance y_f
g_i	Real part of input admittance y_i
g_o	Real part of output admittance y_o
g_r	Real part of reverse transconductance y_r
g_s	Generator conductance
G_C	Current gain
G_P	Power gain
G_{Pav}	Available power gain
G_{Pmax}	Max. available power gain
G_V	Voltage gain
h	Parameters of h - (hybrid) matrix
h_f	Small signal current gain
h_i	Input impedance
h_o	Output admittance
h_r	Reverse voltage transfer ratio
h_{FE}	DC current gain, common emitter
I_B	Base current
I_{BM}	Peak base current
I_{B1}	Turn-on current

I_{B2}	Turn-off current
I_C	Collector current
I_{CAV}	Average collector current
I_{CB0}	Collector base cutoff current (open emitter)
I_{CE0}	Collector emitter cutoff current (open base)
I_{CER}	Collector emitter cutoff current (specified resistance between base and emitter)
I_{CES}	Collector emitter cutoff current (base short-circuited to emitter)
I_{CEV}	Collector emitter cutoff current (specified voltage between base and emitter)
I_{CM}	Peak collector current
I_E	Emitter current
I_{EB0}	Emitter base cutoff current (open collector)
K_V	Thermal resistance correction factor
P_{tot}	Power dissipation
P_D	Continuous power dissipation
P_I	Pulse power dissipation
$r_{b'} \cdot C_c$	Collector base time constant
r_{thA}	Pulse thermal resistance junction to ambient air
r_{thC}	Pulse thermal resistance junction to case
R	Resistance; resistor
R_{BE}	Resistance between base and emitter
R_G	Generator impedance; source impedance
$R_{G\ opt}$	Optimum (matched) generator resistance
R_L	Load resistance
$R_{L\ opt}$	Optimum (matched) load resistance
R_S	Series resistance
R_{th}	Thermal resistance
R_{thA}	Thermal resistance junction to ambient air
R_{thC}	Thermal resistance junction to case resp. mounting base
$R_{thC/S}$	Thermal resistance case or mounting base to heat sink
R_{thS}	Thermal resistance heat sink to ambient air
t	Time
t_d	Delay time
t_f	Fall time
t_{off}	Turn-off time ($t_s + t_f$)
t_{on}	Turn-on time ($t_d + t_r$)
t_p	Pulse duration
t_r	Rise time

Technical Information

t_s	Storage time
t_{total}	Total switching time ($t_{on} + t_{off}$)
T	Temperature; duration of one period
T_{amb}	Ambient temperature
T_j	Junction temperature
T_C	Case temperature
T_S	Storage temperature
V	Voltage
V_{BB}	Base supply voltage
V_{BE}	Base emitter voltage
$V_{BE\ sat}$	Base emitter saturation voltage
$V_{(BR)CBO}$	Collector base breakdown voltage (open emitter)
$V_{(BR)CEO}$	Collector emitter breakdown voltage (open base)
$V_{(BR)CES}$	Collector emitter breakdown voltage (emitter short-circuited to base)
$V_{(BR)EBO}$	Emitter base breakdown voltage (open collector)
V_{CB}	Collector base voltage
V_{CBO}	Collector base voltage (open emitter)
V_{CC}	Collector supply voltage
V_{CE}	Collector emitter voltage
V_{CEO}	Collector emitter voltage (open base)
V_{CER}	Collector emitter voltage (specified resistance between base and emitter)
V_{CES}	Collector emitter voltage (emitter short-circuited to base)
$V_{CE\ sat}$	Collector emitter saturation voltage
V_{CEV}	Collector emitter voltage (specified voltage between base and emitter)
V_{EBO}	Emitter base voltage (open collector)
V_{EE}	Emitter supply voltage
y	Parameters of y - (admittance) matrix
y_f	Forward transconductance
y_i	Input admittance
y_o	Output admittance
y_r	Reverse transconductance
y_s	Generator admittance
Z_1	Input impedance
Z_2	Output impedance
φ	Phase angle of y -parameters
τ_s	Storage time constant
ν	Duty cycle (t_p/T)

Characteristics and Maximum Ratings

The electrical performance of a semiconductor device is usually expressed in terms of its characteristics and maximum ratings.

Characteristics are those which can be measured by use of suitable measuring instruments and circuits, and provide information on the performance of the device under specified operating conditions (at a given bias, for example). Depending on requirements, they are quoted either as typical values or guaranteed values.

Typical values are expressed as figures or as one or more curves, and are subject to spreads.

Guaranteed values are preceded either by the symbol $>$ (greater than) or $<$ (less than); sometimes the guaranteed spread limits are indicated by the numbers with three dots between them. Occasionally a typical curve is accompanied by another curve, this being a 95 %, or, in a few cases, a maximum spread limit curve.

Maximum Ratings give the values which cannot be exceeded without risk of damage to the device. Changes in supply voltage and in the tolerances of other components in the circuit must also be taken into consideration. No single maximum rating should ever be exceeded, even when the device is operated well within the other maximum ratings. The inclusion of the word "admissible" in a title means that the associated curve defines the maximum ratings.

An exception to this rule are data on collector current. The collector current, quoted as one of the critical transistor values, is a maximum value recommended by the manufacturer which should be noted in connection with the other characteristics valid for this collector current (e.g. collector and saturation voltages, current gain etc.) when selecting a transistor. In certain cases, the quoted collector current may be exceeded without the transistor being destroyed. The absolute limit for the collector current is determined by the maximum admissible power dissipation of the transistor.

Technical Information

Assembly and Soldering Instructions

To prevent transistors from being damaged during mounting, observe the following points:

The leads must under no circumstances be bent immediately adjacent to the glass seals. Material stresses set up in this way may produce cracks in the glass, often only after a certain delay, and may lead to the destruction of the component. The point at which leads are bent should not be less than 2 mm away from the glass seal.

All semiconductor devices are extremely sensitive to their maximum admissible junction temperature being exceeded. When planning the layout of the equipment, the distance between heat sources and semiconductor elements should be sufficiently large.

Semiconductor elements may be mounted in any desired position.

From the experience gained in soldering semiconductor elements the following rules have emerged:

When bit-soldering at copper bit temperatures from 230...250 °C, the soldering time should not exceed 5 s. The distance between soldered joint and glass seal should be at least 5 mm. For leads shorter than 5 mm additional heat dissipation must be provided, for example, by means of a cooling clip.

When dip-soldering printed circuits, the temperature of the soldering bath should not exceed 240 °C. If the distance between soldered joint and mounting surface or glass seal is at least 5 mm the maximum dipping time is 10 s. For leads of 3 mm length, the maximum dipping time is restricted to 5 s.

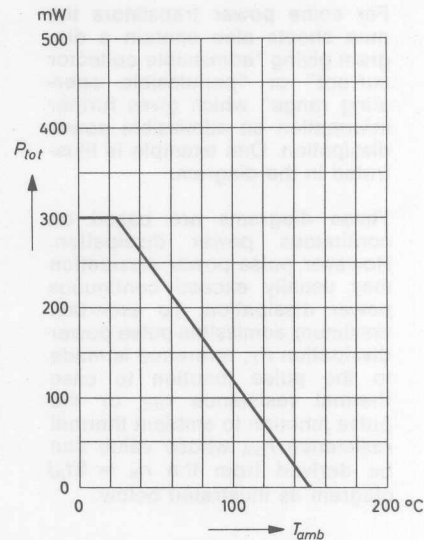
For transistors in plastic cases the maximum soldering time is 8 s, at soldering temperatures between 230 and 260 °C. Here, the distance between soldered joint and case should be at least 4 mm. During soldering, the leads should not be subjected to mechanical stress.

Admissible Power Dissipation

The indicated maximum admissible junction temperature must not be exceeded because this could damage or cause the destruction of the transistor crystal. Since the user cannot measure this temperature, data sheets also reveal the maximum admissible power dissipation P_{tot} usually in the form of a derating curve (see diagram).

If power dissipation is kept within these limits the maximum junction temperature will not be exceeded. This can easily be checked by using the equation

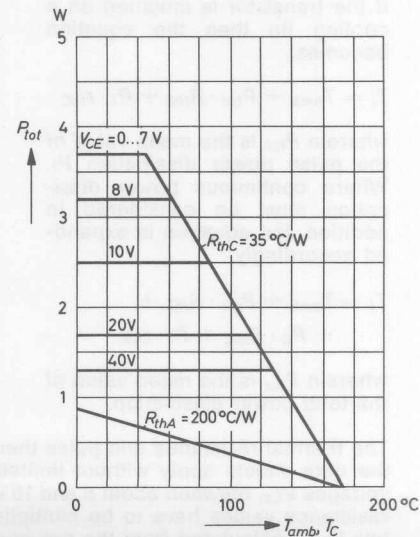
$$T_j = T_{amb} + P_{tot} \cdot R_{th}$$



For the thermal resistance R_{th} the junction to ambient thermal resistance R_{thA} is usually substituted in the case of small transistors (in the TO-18, TO-39 or TO-92 package). In the case of power transistors (in the TO-3, SOT-9 or similar packages) which are usually mounted on a cooling fin or heat sink for the purpose of heat dissipation, the sum of the junction to case thermal resistance R_{thC} plus the heat sink to ambient thermal resistance R_{thS} plus — for more accurate calculations — the mounting surface to heat sink thermal resistance is substituted for the thermal resistance in this equation. In order to keep the mounting surface to heat sink thermal resistance low, a heat conducting compound (silicone grease) is to be applied to the mounting surface before the transistor is screwed on. If a mica insulation is used, the thermal resistance of the mica washer must be added which amounts to about 0.5 °C/W.

Directions for determining the thermal resistance R_{thS} for cooling fins can be found on page 20.

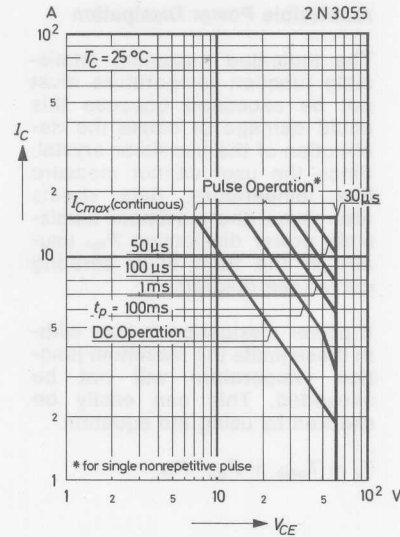
Since the distribution of heat in the transistor crystal is not uniform and depends on voltage and current, some transistors are accompanied by derating curves showing P_{tot} as a function of T_C and T_{amb} with the collector voltage V_{CE} as parameter (see diagram).



Technical Information

For some power transistors the data sheets also contain a diagram giving "admissible collector current" or "permissible operating range" which gives further information on admissible power dissipation. One example is illustrated in the diagram.

These diagrams are based on continuous power dissipation. However, pulse power dissipation may usually exceed continuous power dissipation. To ascertain maximum admissible pulse power dissipation P_I , reference is made to the pulse junction to case thermal resistance r_{thC} or the pulse junction to ambient thermal resistance r_{thA} whose value can be derived from the $r_{th} = f(t_p)$ diagram as illustrated below.



Use the equation

$$T_i = T_{amb} + P_I \cdot r_{thA}$$

or, if the continuous power dissipation P_D is to be taken into consideration:

$$T_i = T_{amb} + P_D \cdot R_{thA} + P_I \cdot r_{thA}$$

If the transistor is mounted on a cooling fin then the equation becomes:

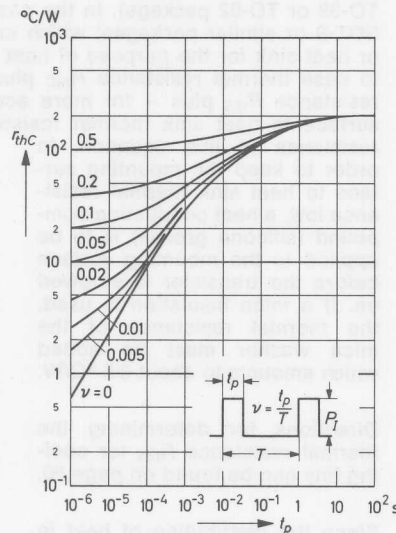
$$T_i = T_{amb} + P_{tot} \cdot R_{thS} + P_I \cdot r_{thC}$$

wherein P_{tot} is the mean value of the pulse power dissipation P_I . Where continuous power dissipation must be considered in addition, the equation is expanded accordingly:

$$T_i = T_{amb} + P_{tot} \cdot R_{thS} + P_D \cdot R_{thC} + P_I \cdot r_{thC}$$

wherein P_{tot} is the mean value of the total power dissipation.

The thermal resistance and pulse thermal resistance values derived from the data sheets apply without limitation only to small collector emitter voltages V_{CE} , between about 5 and 10 V. For higher voltages these thermal resistance values have to be multiplied by a correction factor K_V which has to be calculated from the previously mentioned derating curves. The



admissible power dissipation $P_{tot\ max}$, applicable to low collector voltages, must be divided by the admissible power dissipation $P_{tot\ V}$ for the higher collector voltage V :

$$K_V = \frac{P_{tot\ max}}{P_{tot\ V}}$$

The complete equation for T_j then reads:

$$T_j = T_{amb} + P_{tot} \cdot R_{thS} + P_D \cdot K_V \cdot R_{thC} + P_I \cdot K_V \cdot r_{thC}$$

Heat Removal from Transistors

The operation of any semiconductor device involves the dissipation of power with a consequent rise in junction temperature. Because the maximum admissible junction temperature must not be exceeded, careful circuit design with due regard not only to the electrical, but also the thermal performance of a semiconductor circuit, is essential.

If the dissipated power is low, then sufficient heat is radiated from the surface of the case; if the dissipation is high, however, additional steps may have to be taken to promote this process by reducing the thermal resistance between the junction and the ambient air. This can be achieved either by pushing a star- or flag-shaped heat dissipator over the case, or by bolting the semiconductor device to a heat sink.

P , the power to be dissipated, T_j the junction temperature, and T_{amb} , the ambient temperature are related by the formula

$$P = \frac{T_j - T_{amb}}{R_{thA}} = \frac{T_j - T_{amb}}{R_{thC} + R_{thS}},$$

where R_{thA} is the total thermal resistance between junction and ambient air. The total thermal resistance in turn comprises an internal thermal resistance R_{thC} between the junction and the mounting base, and an outer thermal resistance R_{thS} between the case and the surrounding air (or any other cooling medium). It should be noted that only the outer thermal resistance is affected by the design of the heat sink. To determine the size of the heat sink required to meet given operating conditions, proceed as follows: First calculate the outer thermal resistance by use of the formula

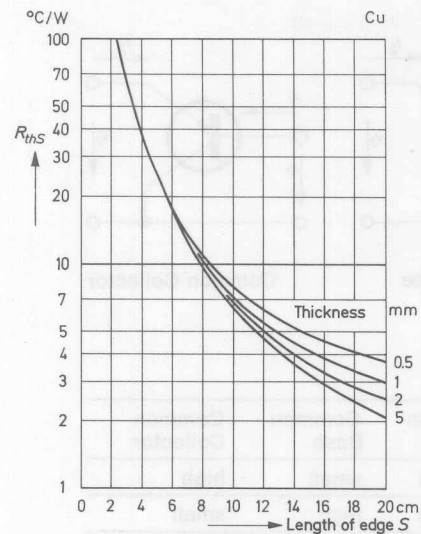
$$R_{thS} < \frac{T_j - T_{amb}}{P} - R_{thC}$$

and then, by use of the diagrams shown on next page, determine the size of the heat sink which provides the calculated R_{thS} -value. To determine the maximum admissible device dissipation and ambient temperature limit for a given heat sink, proceed in the reverse order to that described above.

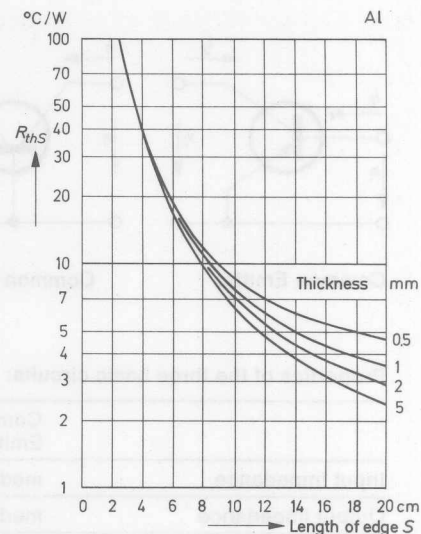
The calculations are based on the following assumptions: Use of a squareshaped heat sink without any finish, mounted in a vertical position; semiconductor device located in the centre of the sink; heat sink operated in still air and not subjected to any additional heat radiation. The calculated area should be increased by a factor of 1.3 if the sink is mounted horizontally, and can be reduced by a factor of approximately 0.7 if a black finish is used.

The curves on the following page give the thermal to ambient resistance of square vertical heat sinks as a function of side length. It is assumed that the heat is applied at the centre of the square.

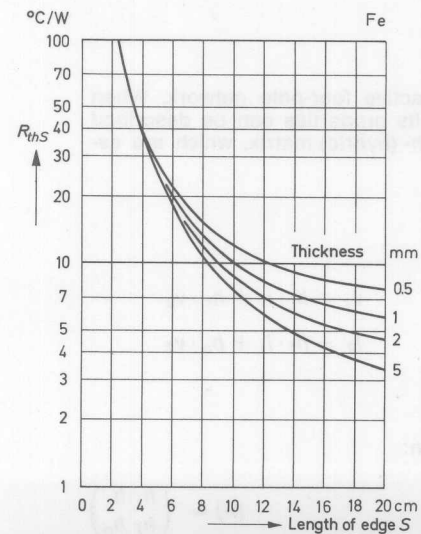
Copper Cooling Fin



Aluminium Cooling Fin



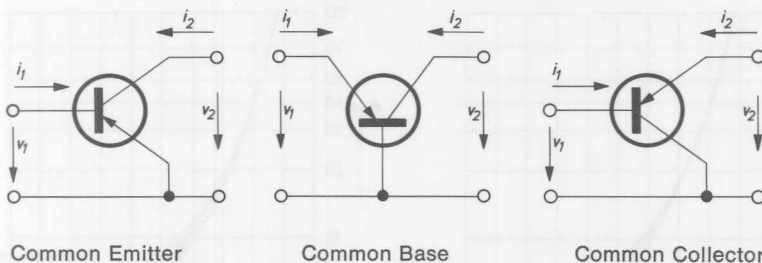
Steel Cooling Fin



Technical Information

Basic Circuits

There are three basic transistor circuits. They are called according to that electrode (emitter, base, collector) which is common to both input and output circuit.

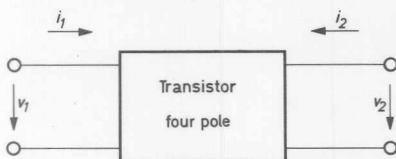


Properties of the three basic circuits:

	Common Emitter	Common Base	Common Collector
Input impedance	medium	small	high
Output impedance	medium	high	small
Current gain	high	less than 1	high
Upper frequency limit	low	high	low

Four-Pole Symbols of h -Matrix

A transistor can be considered as an active four-pole network. When driven with small low-frequency signals its properties can be described by the four characteristic values of the h - (hybrid) matrix, which are assumed to be real.



$$v_1 = h_i \cdot i_1 + h_r \cdot v_2$$

$$i_2 = h_f \cdot i_1 + h_o \cdot v_2$$

If expressed this in matrix form we obtain:

$$\begin{pmatrix} v_1 \\ i_2 \end{pmatrix} = (h) \begin{pmatrix} i_1 \\ v_2 \end{pmatrix}$$

$$(h) = \begin{pmatrix} h_i & h_r \\ h_f & h_o \end{pmatrix}$$

Explanation of h -Parameters

 Input impedance (shorted output) ($v_2 = 0$):

$$h_i = \frac{v_1}{i_1}$$

 Reverse voltage transfer ratio (open input) ($i_1 = 0$):

$$h_r = \frac{v_1}{v_2}$$

 Small signal current gain (shorted output) ($v_2 = 0$):

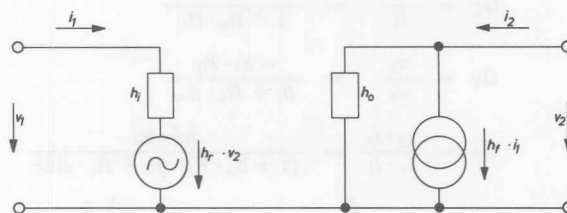
$$h_f = \frac{i_2}{i_1}$$

 Output admittance (open input) ($i_1 = 0$):

$$h_o = \frac{i_2}{v_2}$$

A frequently used abbreviation is the determinant:

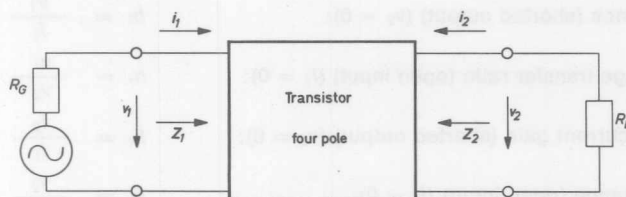
$$\Delta h = h_i \cdot h_o - h_r \cdot h_f$$

 For all three basic circuit configurations the circuit illustrated below represents the equivalent four-pole circuit using h -parameters.


In the transistor data sheets the h -parameters are usually quoted for the common emitter configuration and for a given operating point (bias). The latter is determined by the collector voltage, the emitter or collector current and by the ambient temperature. For different operating points, correction factors are needed which can be gathered from the relevant curves. For common base or common collector transistor stage calculations, the appropriate h -parameters are ascertained from those of the common emitter configuration by using the following conversion formulas.

	Common Emitter	Common Base	Common Collector
Input impedance	h_{ie}	$h_{ib} = \frac{h_{ie}}{1 + h_{fe}}$	$h_{ic} = h_{ie}$
Reverse voltage transfer ratio	h_{re}	$h_{rb} = \frac{h_{ie} \cdot h_{oe}}{1 + h_{fe}} - h_{re}$	$h_{rc} = 1 - h_{re}$
Small signal current gain	h_{fe}	$h_{fb} = -\frac{h_{fe}}{1 + h_{fe}}$	$-h_{fc} = 1 + h_{fe}$
Output admittance	h_{oe}	$h_{ob} = \frac{h_{oe}}{1 + h_{fe}}$	$h_{oc} = h_{oe}$

Calculation of a Transistor Stage



Input impedance $Z_1 = \frac{v_1}{i_1} = \frac{h_i + R_L \cdot \Delta h}{1 + h_o \cdot R_L}$

Output impedance $Z_2 = \frac{v_2}{i_2} = \frac{h_i + R_G}{\Delta h + h_o \cdot R_G}$

Current gain $G_C = \frac{i_2}{i_1} = \frac{h_f}{1 + h_o \cdot R_L}$

Voltage gain $G_V = \frac{v_2}{v_1} = \frac{-h_f \cdot R_L}{h_i + R_L \cdot \Delta h}$

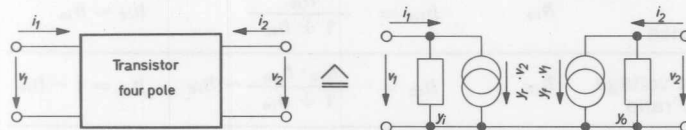
Power gain $G_P = \frac{v_2 \cdot i_2}{v_1 \cdot i_1} = \frac{h_f^2 \cdot R_L}{(1 + h_o \cdot R_L)(h_i + R_L \cdot \Delta h)}$

Max. available power gain input and output matched with $R_{G \text{ opt}}$ resp. $R_{L \text{ opt}}$ $G_{P \text{ max}} = \left(\frac{h_f}{\sqrt{\Delta h} + \sqrt{h_i \cdot h_o}} \right)^2$

$$R_{G \text{ opt}} = \sqrt{\frac{h_i \cdot \Delta h}{h_o}} \quad R_{L \text{ opt}} = \sqrt{\frac{h_i}{h_o \cdot \Delta h}}$$

Four-Pole Symbols of y-Matrix

Whereas the network behaviour of low-frequency transistors could be described by using the h - (hybrid) matrix, the y - (admittance) matrix is usually employed for high frequency transistors.



$$i_1 = y_i \cdot v_1 + y_r \cdot v_2$$

$$i_2 = y_f \cdot v_1 + y_o \cdot v_2$$

In matrix form we obtain:

$$\begin{pmatrix} i_2 \\ i_1 \end{pmatrix} = (y) \begin{pmatrix} v_1 \\ v_2 \end{pmatrix} \quad (y) = \begin{pmatrix} y_i & y_r \\ y_f & y_o \end{pmatrix}$$

The y -parameters are complex values which can be expressed as

$$y_{ik} = g_{ik} + jb_{ik} \quad \text{with } b_{ik} = \omega C_{ik} \text{ or with } b_{ik} = -\frac{1}{\omega L_{ik}}$$

Often, the following notation is expedient:

$$y_{ik} = |y_{ik}| \exp j\varphi_{ik}$$

By adding the suffix e , b or c it is possible to indicate to which of the three basic circuit configurations the parameters are valid.

Explanation of y -Parameters

$$\text{Input admittance (shorted output) } (v_2 = 0) \quad y_i = \frac{i_1}{v_1}$$

$$\text{Reverse transconductance (shorted input) } (v_1 = 0) \quad y_r = \frac{i_1}{v_2}$$

$$\text{Forward transconductance (shorted output) } (v_2 = 0) \quad y_f = \frac{i_2}{v_1}$$

$$\text{Output admittance (shorted input) } (v_1 = 0) \quad y_o = \frac{i_2}{v_2}$$

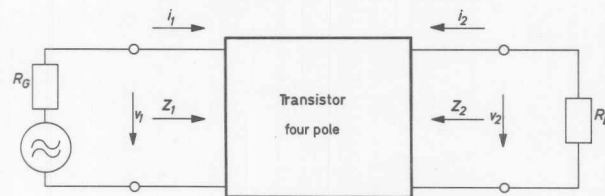
$$\text{The determinant reads } \Delta y = y_i \cdot y_o - y_r \cdot y_f$$

Conversion from y -Parameters to h -Parameters

$$h_i = \frac{1}{y_i} \quad h_r = -\frac{y_r}{y_i} \quad \Delta h = \frac{y_o}{y_i}$$

$$h_f = \frac{y_f}{y_i} \quad h_o = \frac{\Delta y}{y_i}$$

Calculation of a Transistor Stage



$$\text{Input impedance } Z_1 = \frac{v_1}{i_1} = \frac{1 + y_o \cdot R_L}{y_i + \Delta y \cdot R_L}$$

Technical Information

Output impedance

$$Z_2 = \frac{v_2}{i_2} = \frac{1 + y_i \cdot R_G}{y_o + \Delta y \cdot R_G}$$

Current gain

$$G_C = \frac{i_2}{i_1} = \frac{y_f}{y_i + \Delta y \cdot R_L}$$

Voltage gain

$$G_V = \frac{v_2}{v_1} = \frac{-y_f \cdot R_L}{1 + y_o \cdot R_L}$$

Power gain

$$G_P = \frac{v_2 \cdot i_2}{v_1 \cdot i_1} = \frac{|y_f|^2 \cdot R_L}{(1 + y_o \cdot R_L)(y_i + \Delta y \cdot R_L)}$$

Available power gain
input matched
with $R_{G \text{ opt}}$

$$G_{P \text{ av}} = \frac{4 \cdot y_f^2 \cdot R_G \cdot R_L}{[(y_i + \Delta y \cdot R_L) \cdot R_G + 1 + y_o \cdot R_L]^2}$$

Max. available power gain
input and output matched
with $R_{G \text{ opt}}$ resp. $R_{L \text{ opt}}$

$$G_{P \text{ max}} = \left(\frac{y_f}{\sqrt{\Delta y} + \sqrt{y_i \cdot y_o}} \right)^2$$

Max. available power gain will be attained if input and output are matched,
where:

$$R_{L \text{ opt}} = \sqrt{\frac{y_o}{y_i} \cdot \frac{1}{\Delta y}}$$

$$R_{G \text{ opt}} = \sqrt{\frac{y_i}{y_o} \cdot \frac{1}{\Delta y}}$$

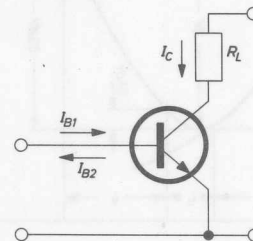
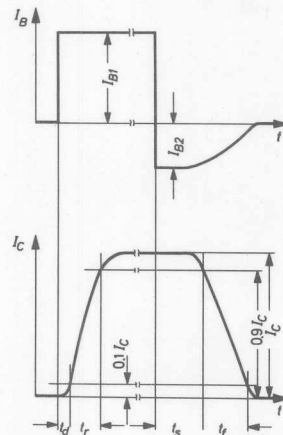
and:

$$\Delta y = y_i \cdot y_o - y_r \cdot y_f$$



Switching Times

Definitions for the various times which make up the total switching time can be gathered from the diagram below in which the switching characteristic of a transistor in common-emitter configuration is illustrated.



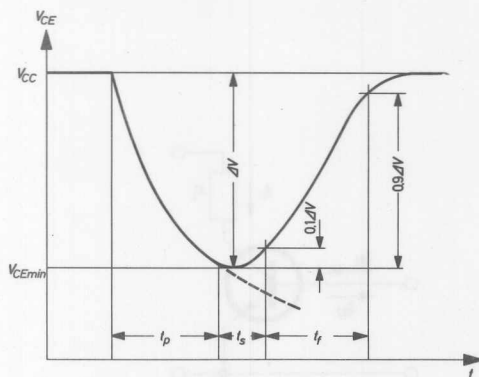
t_d	Delay time
t_r	Rise time
t_s	Storage time
t_f	Fall time
$t_{on} = t_d + t_r$	Turn-on time
$t_{off} = t_s + t_f$	Turn-off time

The duration of the switching times depends upon the transistor type and very much on the circuit arrangement.

With increasing saturation of the transistor the turn-on time decreases and the turn-off time increases. An increase of the turn-off current I_{B2} shortens the turn-off time.

Technical Information

The switching times depend on the duration of the turn-on pulse. It is only when the duration of this pulse is a multiple of the switching times that the latter remain constant. If the pulse is shorter, especially the storage time decreases. With a pulse duration in the region of the turn-on time the transistor is no longer fully saturated. The collector voltage then exhibits a characteristic such as is qualitatively represented in the diagram below.



DIN Standards (German)

The information contained in this book conforms, in the main, to the following German DIN Standards.

DIN 41785 Sheet 1 (10. 69)	Semiconductor devices, letter symbols on data sheets, general
DIN 41785 Sheet 2 (9. 71)	Semiconductor devices, letter symbols on data sheets for semiconductor devices for telecommunication
DIN 41791 Sheet 1 (9. 71)	Semiconductors for telecommunication, recommendations for data sheets, general
DIN 41791 Sheet 4 (E 10. 71)	Semiconductor devices for telecommunication, recommendations for data sheets, low power signal transistors
DIN 41791 Sheet 6 (10. 73)	Semiconductor devices for telecommunication, recommendations for data sheets, switching transistors
DIN 41854 (11. 67)	Transistors, terms and definitions
DIN 41855 (10. 74)	Semiconductor devices, kinds of semiconductor devices, terms and definitions
DIN 41868 (4. 72)	Cases 10 A 3 and 10 B 3 (JEDEC TO-92) for semiconductor devices, main dimensions
DIN 41870 Sheet 1 (4. 69)	Cases for semiconductor devices and integrated circuits, short designations
DIN 41870 Sheet 2 (7. 69)	Cases for semiconductor devices and integrated circuits, survey
DIN 41873 (6. 74)	Cases type 5 (JEDEC TO-39 \approx TO-5) for semiconductor devices and integrated circuits
DIN 41876 (4. 72)	Cases 18 A 3 (JEDEC TO-18) etc. for semiconductor devices, main dimensions

Specifications for Quality

1. General

The quality of components is determined by statistical methods, and is quoted as a maximum permissible percentage of defectives (AQL value). AQL values are based on maximum ratings and guaranteed characteristics of electrical and mechanical parameters.

2. Defectives

A device is considered defective if any one parameter does not correspond with the value specified in the data sheet. If an item has more than one defect, then this is counted as one defect only, i.e. a batch is assessed on the number of defective items and not on the number of defects. Defects are classified according to type and extent.

Types of defects:

- a) Case or lead defects
- b) Electrical defects

Extent of defects:

- a) Total defects are those which preclude any use of the item
- b) Partial defects are those which allow restricted use of the item

3. AQL (Acceptable Quality Level) Values

The AQL values applicable to INTERMETALL semiconductor devices are summarized in the table below. The AQL values stated apply to the sum of all defectives.

Defectives

Case and leads:

Total defectives	0.25 %
Partial defectives	2.50 %

Electrical properties:

Total defectives	0.25 %
Partial defectives	0.65 %

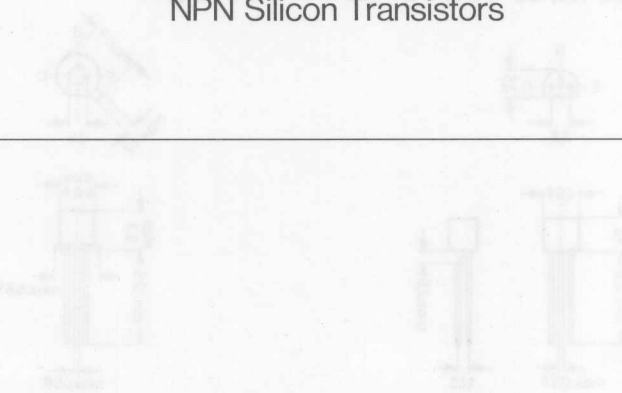
4. Incoming Inspection

The tests carried out by the manufacturer are designed so as to obviate the need for any incoming inspection by the user. If, however, a user wishes to carry out an incoming inspection, then this should be done on a sample basis, as laid down in the internationally accepted MIL-STD 105 D specifications.

NPN Silicon Transistors

The transistors are subdivided into three groups A, B and C according to their current gain types BC 107, BC 108, BC 171, BC 172 and BC 237 are available in groups A and B, while BC 109, BC 173 and BC 238 in groups A, B and C, and

BC 107, BC 108, BC 171, BC 172, BC 173, BC 237, BC 238, BC 239



BC 107, BC 108, BC 171, BC 172, BC 173, BC 237, BC 238, BC 239

BC 109, BC 173, BC 174, BC 239, BC 240, BC 241

Mount case JEDEC TO-18
As a standard to DIN 47 578
Collector connected to case
Weight approximately 0.25 g
Dimensions in mm

Mount case JEDEC TO-18
As a standard to DIN 47 578
Collector connected to case
Weight approximately 0.25 g
Dimensions in mm

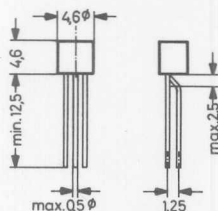
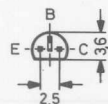
Maximum Ratings		TO-18		TO-18A	
Collector-emitter voltage	V_{CE}	50	50	50	50
Collector-base voltage	V_{CB}	40	40	40	40
Emitter-base voltage	V_{EB}	5	5	5	5
Collector current	I_C	100	100	100	100
Pulse collector current	I_{CP}	200	200	200	200
Base current	I_B	20	20	20	20
Power dissipation	P_{tot}	300	300	300	300
at $T_{amb} = 25^\circ C$					
Junction temperature	T_j	150	150	150	150
Storage temperature range	T_s	-55 ... +125	-55 ... +125	-55 ... +125	-55 ... +125

Values provided for loads are kept at ambient temperature at a distance of 2 mm from case

BC 107..., BC 171, BC 190, BC 237...

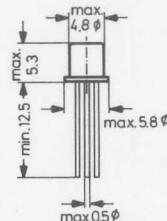
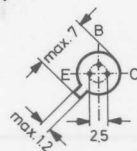
NPN Silicon Epitaxial Planar Transistors for switching and amplifier applications

The transistors are subdivided into three groups A, B and C according to their current gain. Types BC 107, BC 190, BC 171, BC 174 and BC 237 are available in groups A and B, types BC 108, BC 172 and BC 238 in groups A, B and C, and types BC 109, BC 173 and BC 239 in groups B and C. BC 109, BC 173 and BC 239 are low noise types.



**BC 171, BC 172, BC 173, BC 174
BC 237, BC 238, BC 239**

Plastic package \approx JEDEC TO-92
TO-18 compatible
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm



BC 107, BC 108, BC 109, BC 190

Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

BC 107	BC 108	BC 190
BC 171	BC 109	BC 174
BC 237	BC 172	
	BC 173	
	BC 238	
	BC 239	

Maximum Ratings

Collector emitter voltage	V_{CES}	50	30	70	V
Collector emitter voltage	V_{CEO}	45	25	64	V
Emitter base voltage	V_{EB0}	6	5	5	V
Collector current	I_C	100	100	100	mA
Peak collector current	I_{CM}	200	200	200	mA
Base current	I_B	50	50	50	mA

		TO-92	TO-18	
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}	300 ¹	300	mW
Junction temperature	T_j	150	175	$^\circ\text{C}$
Storage temperature range	T_s	- 55 ... + 150	- 55 ... + 175	$^\circ\text{C}$

¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

BC 107..., BC 171..., BC 190, BC 237...

Characteristics at $T_{amb} = 25^\circ\text{C}$

h -Parameters at $V_{CE} = 5\text{ V}$,
 $I_C = 2\text{ mA}$, $f = 1\text{ kHz}$

		A	B	C
Small signal current gain	h_{fe}	220 (125 .. 260)	330 (240 .. 500)	600 (450 .. 900)
Input impedance	h_{ie}	2.7 (1.6 .. 4.5)	4.5 (3.2 .. 8.5)	8.7 (6 ... 15) $\text{k}\Omega$
Output admittance	h_{oe}	18 (< 30)	30 (< 60)	60 (< 110) μmho
Reverse voltage transfer ratio	h_{re}	$1.5 \cdot 10^{-4}$	$2 \cdot 10^{-4}$	$3 \cdot 10^{-4}$

DC current gain

at $V_{CE} = 5\text{ V}$, $I_C = 0.01\text{ mA}$

at $V_{CE} = 5\text{ V}$, $I_C = 2\text{ mA}$

at $V_{CE} = 5\text{ V}$, $I_C = 100\text{ mA}$

h_{FE}	90	150	270
h_{FE}	170	290	500
h_{FE}	120 ¹	200 ¹	400 ¹

Collector saturation voltage

at $I_C = 10\text{ mA}$, $I_B = 0.5\text{ mA}$

at $I_C = 100\text{ mA}$, $I_B = 5\text{ mA}$

V_{CEsat}	0.07 (< 0.2)	V
V_{CEsat}	0.2 (< 0.6) ¹	V

Base saturation voltage

at $I_C = 10\text{ mA}$, $I_B = 0.5\text{ mA}$

at $I_C = 100\text{ mA}$, $I_B = 5\text{ mA}$

V_{BEsat}	0.73 (< 0.83)	V
V_{BEsat}	0.87 (< 1.05) ¹	V

Base emitter voltage

at $V_{CE} = 5\text{ V}$, $I_C = 0.1\text{ mA}$

at $V_{CE} = 5\text{ V}$, $I_C = 2\text{ mA}$

at $V_{CE} = 5\text{ V}$, $I_C = 100\text{ mA}$

V_{BE}	0.55	V
V_{BE}	0.62 (0.55 ... 0.7)	V
V_{BE}	0.83 ¹	V

BC 107	BC 108	BC 190
BC 171	BC 109	BC 174
BC 237	BC 172	
	BC 173	
	BC 238	
	BC 239	

Collector cutoff current

at $V_{CE} = 60\text{ V}$

at $V_{CE} = 50\text{ V}$

at $V_{CE} = 30\text{ V}$

at $V_{CE} = 60\text{ V}$, $T_{amb} = 125^\circ\text{C}$

at $V_{CE} = 50\text{ V}$, $T_{amb} = 125^\circ\text{C}$

at $V_{CE} = 30\text{ V}$, $T_{amb} = 125^\circ\text{C}$

I_{CES}	—	—	0.2 (< 15) nA
I_{CES}	0.2 (< 15)	—	— nA
I_{CES}	—	0.2 (< 15)	— nA
I_{CES}	—	—	0.2 (< 4) μA
I_{CES}	0.2 (< 4)	—	— μA
I_{CES}	—	0.2 (< 4)	— μA

Collector emitter breakdown voltage at $I_C = 2\text{ mA}$

$V_{(BR)CEO}$	> 45	> 25	> 64	V
---------------	------	------	------	---

Emitter base breakdown voltage at $I_E = 1\text{ }\mu\text{A}$

$V_{(BR)EBO}$	> 6	> 5	> 5	V
---------------	-----	-----	-----	---

¹ not valid for BC 109, BC 173 and BC 239

BC 107..., BC 171..., BC 190, BC 237...

Gain bandwidth product
at $V_{CE} = 3 \text{ V}$, $I_C = 0.5 \text{ mA}$
at $V_{CE} = 5 \text{ V}$, $I_C = 10 \text{ mA}$
 $f = 100 \text{ MHz}$

f_T	85	MHz
f_T	250 (> 150)	MHz

Collector base capacitance
at $V_{CB0} = 10 \text{ V}$, $f = 1 \text{ MHz}$

C_{CB0}	3.5 (< 6)	pF
-----------	-----------	----

Emitter base capacitance
at $V_{EB0} = 0.5 \text{ V}$, $f = 1 \text{ MHz}$

C_{EB0}	8	pF
-----------	---	----

**BC 107, BC 108, BC 171, BC 172
BC 174, BC 190, BC 237, BC 238:**

Noise figure
at $V_{CE} = 5 \text{ V}$, $I_C = 0.2 \text{ mA}$,
 $R_G = 2 \text{ k}\Omega$, $f = 1 \text{ kHz}$

F	2 (< 10)	dB
-----	----------	----

BC 109, BC 173 and BC 239:

Noise figure
at $V_{CE} = 5 \text{ V}$, $I_C = 0.2 \text{ mA}$,
 $R_G = 2 \text{ k}\Omega$, $f = 1 \text{ kHz}$

F	< 4	dB
-----	-----	----

Noise figure
at $V_{CE} = 5 \text{ V}$, $I_C = 0.2 \text{ mA}$,
 $R_G = 2 \text{ k}\Omega$, $f = 30 \text{ Hz} \dots 15 \text{ kHz}$

F	< 4	dB
-----	-----	----

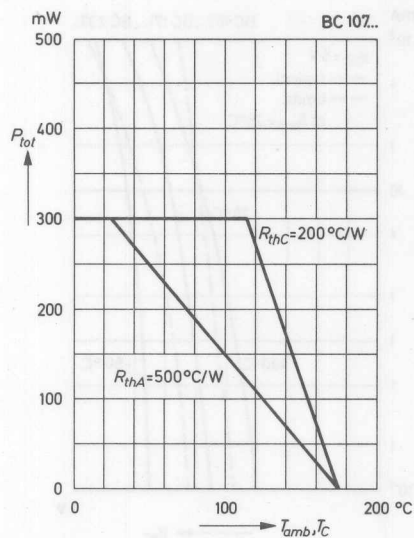
Thermal resistance
Junction to case
Junction to ambient air

	TO-92	TO-18	
R_{thC}	—	< 200	$^{\circ}\text{C/W}$
R_{thA}	< 420 ¹	< 500	$^{\circ}\text{C/W}$

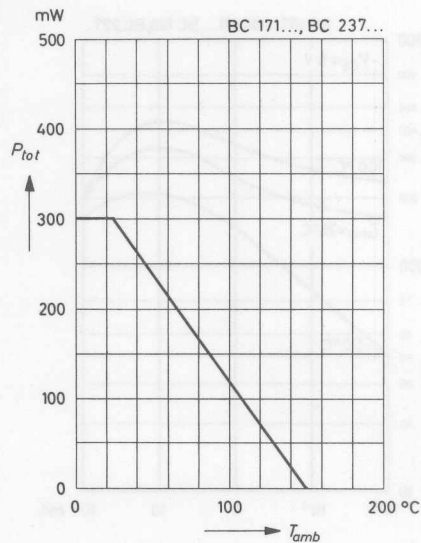
¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

BC 107..., BC 171..., BC 190, BC 237...

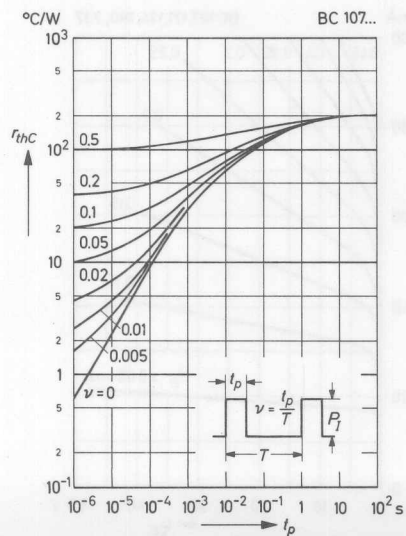
**Admissible power dissipation
versus temperature**



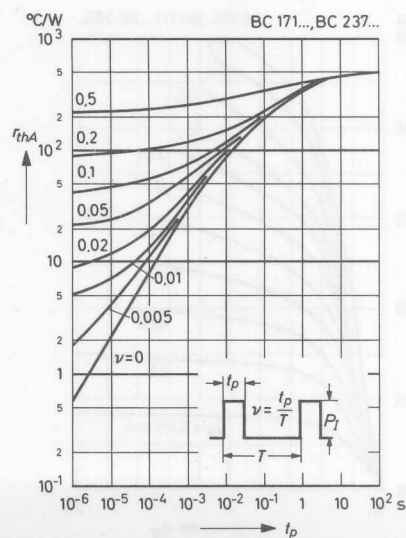
**Admissible power dissipation
versus ambient temperature**
(see note on page 34)



**Pulse thermal resistance
versus pulse duration**

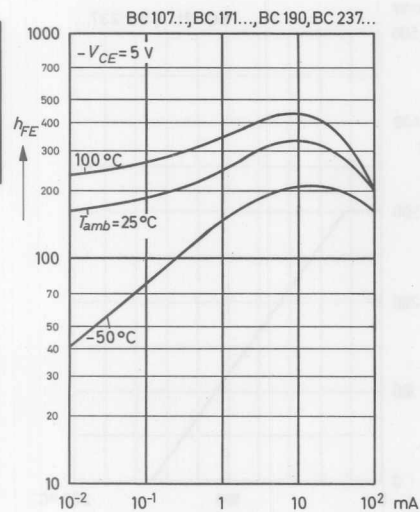


**Pulse thermal resistance
versus pulse duration**
(see note on page 34)

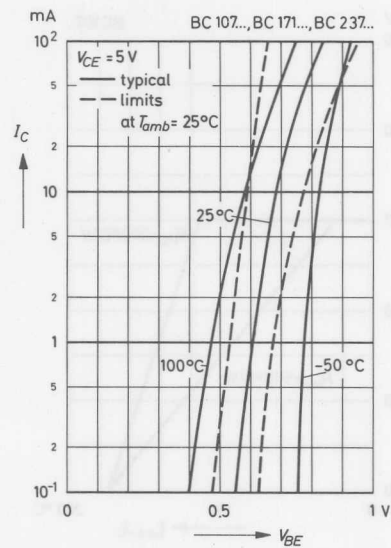


BC 107..., BC 171..., BC 190, BC 237...

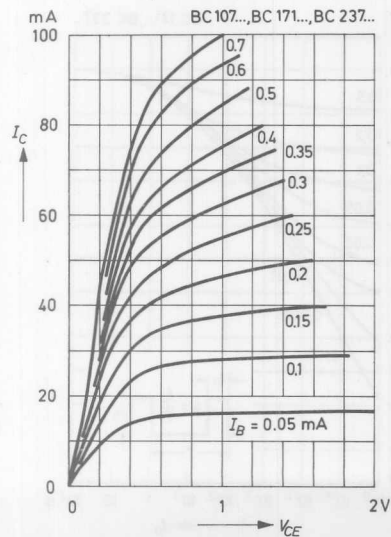
**DC current gain
versus collector current**



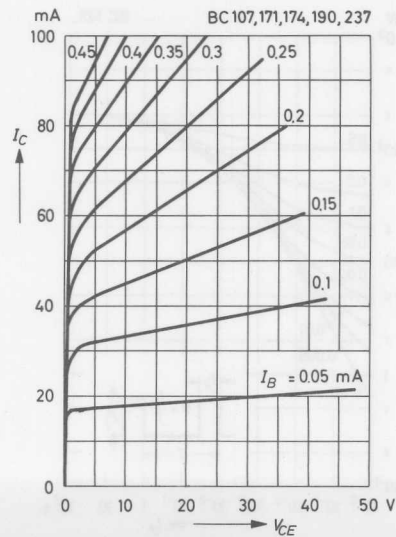
**Collector current
versus base emitter voltage**



**Common emitter
collector characteristics**

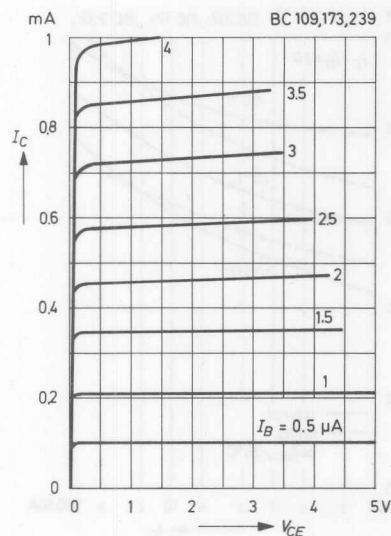


**Common emitter
collector characteristics**

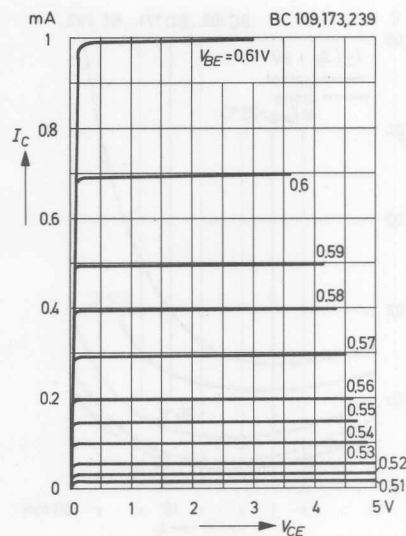


BC 107..., BC 171..., BC 190, BC 237...

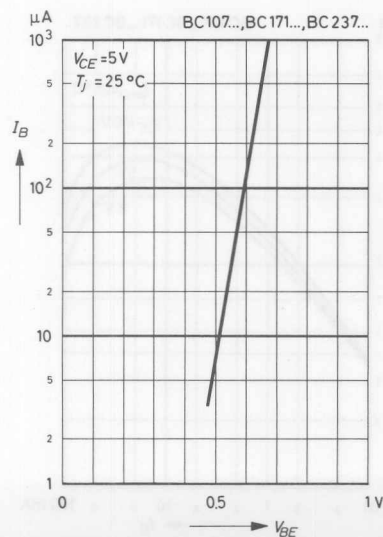
**Common emitter
collector characteristics**



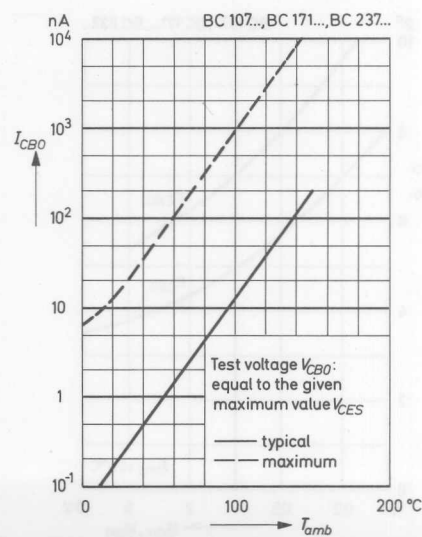
**Common emitter
collector characteristics**



**Common emitter
input characteristic**

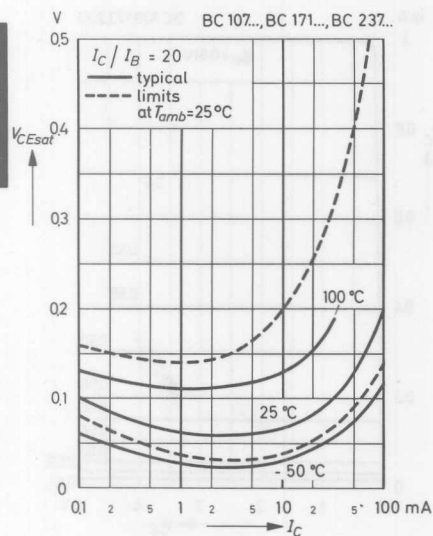


**Collector cutoff current
versus ambient temperature**

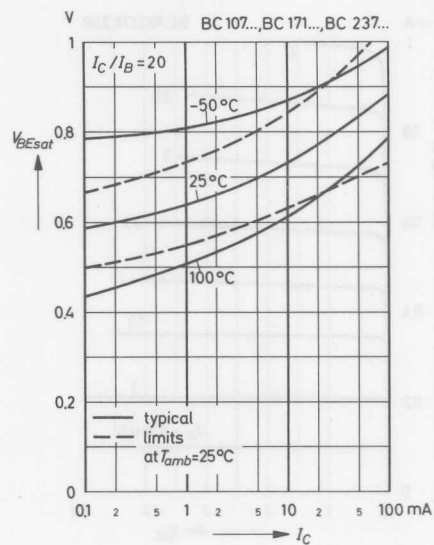


BC 107..., BC 171..., BC 190, BC 237...

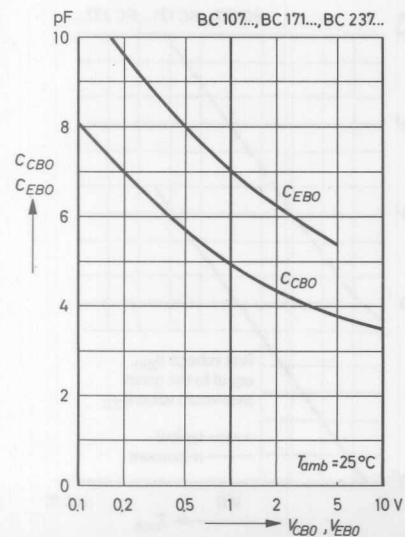
**Collector saturation voltage
versus collector current**



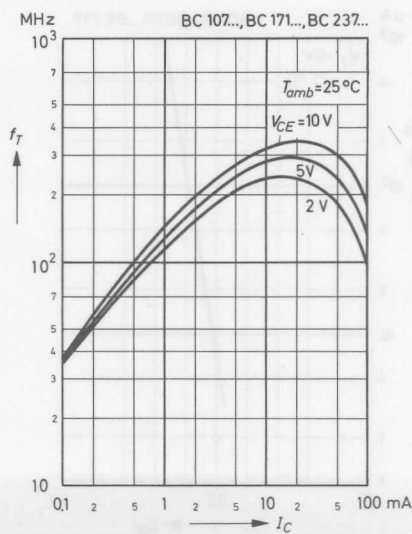
**Base saturation voltage
versus collector current**



**Collector base capacitance,
Emitter base capacitance
versus reverse bias voltage**

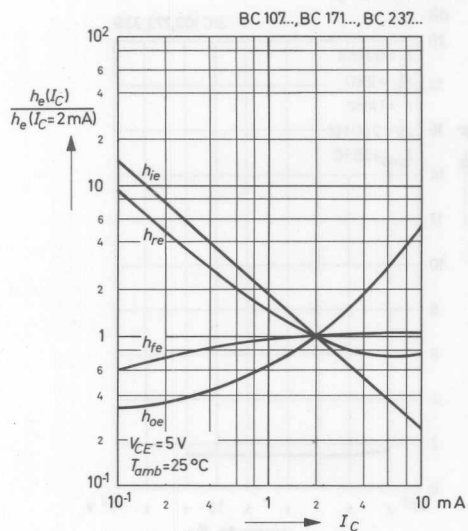


**Gain bandwidth product
versus collector current**

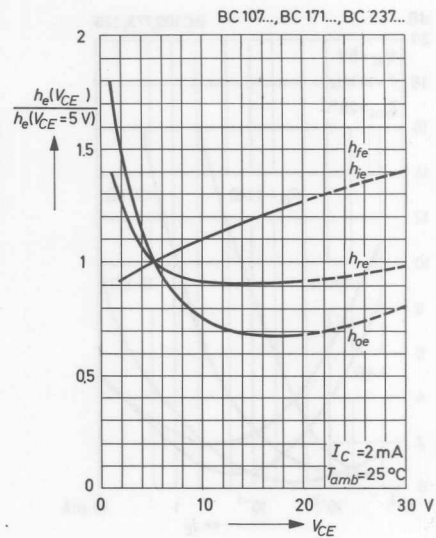


BC 107..., BC 171..., BC 190, BC 237...

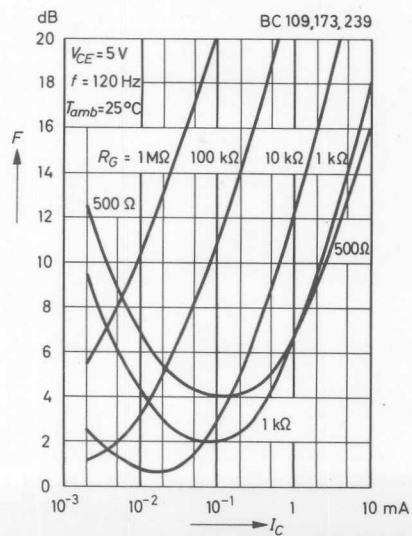
**Relative h -parameters
versus
collector current**



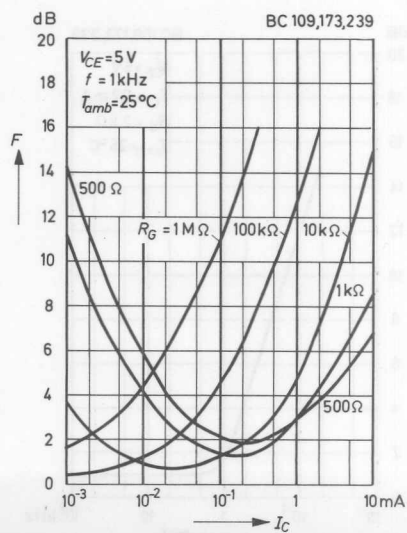
**Relative h -parameters
versus
collector emitter voltage**



**Noise figure
versus collector current**

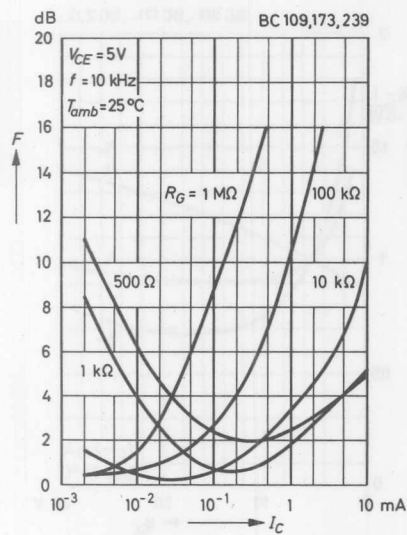


**Noise figure
versus collector current**

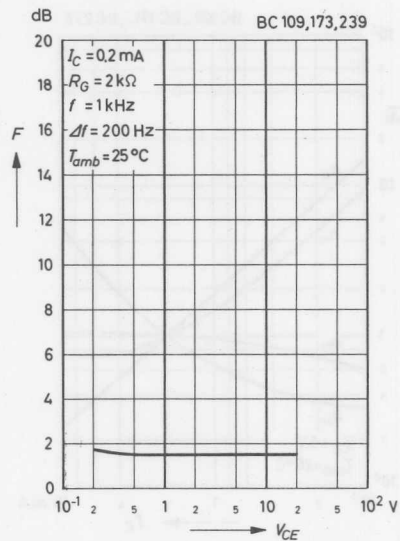


BC 107..., BC 171..., BC 190, BC 237...

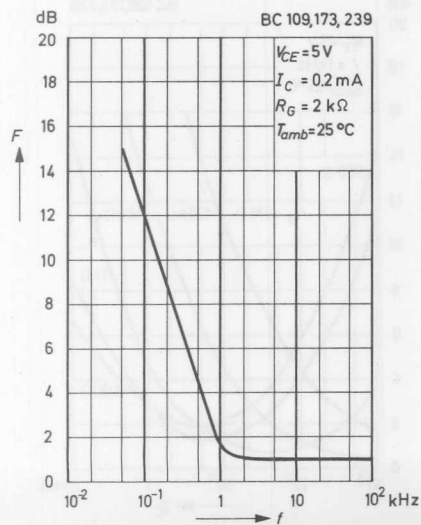
**Noise figure
versus collector current**



**Noise figure versus
collector emitter voltage**



**Noise figure
versus frequency**



These types are suitable for linear operation in switching and amplifier applications.

These types are suitable for linear operation in switching and amplifier applications. BC 107 and BC 171 are recommended.



Mean case JEDEC TO-18
5°C according to DIN 41 612
Collector connected to base
Weight approximately 1 g
Dimensions in mm

Parameter	BC 107	BC 171	BC 190
Collector base voltage	V _{CE}	100	80
Collector emitter voltage	V _{CE}	40	40
Emitter base voltage	V _{BE}	7	7
Collector current	I _C	1	1
Base current	I _B	0.1	0.1
Power dissipation	P _{tot}	0.15	0.15
Junction temperature	T _j	175	175
Storage temperature range	T _s	-55...+125	-55...+125

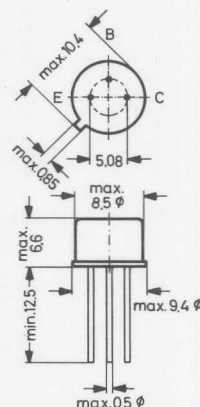
Parameter	BC 107	BC 171	BC 190
DC current gain	h _{FE}	100	100
at V _{CE} = 1 V, I _B = 0.1 mA	h _{FE}	100	100
at V _{CE} = 1 V, I _C = 10 mA	h _{FE}	100	100
at V _{CE} = 1 V, I _C = 1 A	h _{FE}	100	100
Collector emitter voltage	V _{CE}	100	100
at I _C = 1 A, I _B = 10 mA	V _{CE}	100	100
Base emitter voltage	V _{BE}	1.2	1.2
at V _{CE} = 1 V, I _C = 1 A	V _{BE}	1.2	1.2

BC 140, BC 141

NPN Silicon Epitaxial Planar Transistors for switching and amplifier applications

These types are subdivided into three groups -6, -10 and -16, according to their DC current gain. As complementary types the PNP transistors BC 160 and BC 161 are recommended.

Metal case JEDEC TO-39
5 C 3 according to DIN 41873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



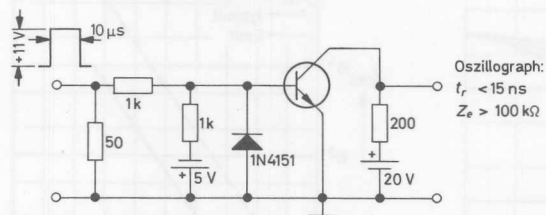
Maximum Ratings		BC 140	BC 141	V
Collector base voltage	V_{CB0}	80	100	V
Collector emitter voltage	V_{CE0}	40	60	V
Emitter base voltage	V_{EB0}	7	7	A
Collector current	I_C	1		A
Base current	I_B	0.1		W
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.75		W
at $T_C = 45^\circ\text{C}$	P_{tot}	3.7		
Junction temperature	T_j	175		$^\circ\text{C}$
Storage temperature range	T_S	-55 ... +175		$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$		BC 140-6 BC 141-6	BC 140-10 BC 141-10	BC 140-16 BC 141-16
DC current gain				
at $V_{CE} = 1\text{ V}$, $I_C = 0.1\text{ mA}$	h_{FE}	28	40	90
at $V_{CE} = 1\text{ V}$, $I_C = 100\text{ mA}$	h_{FE}	63 (40 ... 100)	100 (63 ... 160)	160 (100 ... 250)
at $V_{CE} = 1\text{ V}$, $I_C = 1\text{ A}$	h_{FE}	15	20	30
Collector saturation voltage at $I_C = 1\text{ A}$, $I_B = 100\text{ mA}$	$V_{CE\text{ sat}}$		0.6 (< 1)	V
Base emitter voltage at $V_{CE} = 1\text{ V}$, $I_C = 1\text{ A}$	V_{BE}		1.2 (< 1.8)	V

BC 140, BC 141

	BC 140	BC 141
Collector cutoff current		
at $V_{CE} = 40$ V	I_{CES} 10 (< 100)	— nA
at $V_{CE} = 60$ V	I_{CES} —	10 (< 100) nA
at $V_{CE} = 40$ V, $T_j = 150$ °C	I_{CES} 10 (< 100)	— μA
at $V_{CE} = 60$ V, $T_j = 150$ °C	I_{CES} —	10 (< 100) μA
Collector emitter breakdown voltage		
at $I_C = 0.1$ mA	$V_{(BR)CES}$ > 80	> 100 V
at $I_C = 30$ mA (pulsed 200 μs, 1 %)	$V_{(BR)CEO}$ > 40	> 60 V
Emitter base breakdown voltage	$V_{(BR)EBO}$ > 7	— V
at $I_E = 0.1$ mA		
Gain bandwidth product	f_T	> 50 MHz
at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 20$ MHz		
Collector base capacitance	C_{CB0}	< 25 pF
at $V_{CB0} = 10$ V, $f = 1$ MHz		
Emitter base capacitance	C_{EB0}	< 80 pF
at $V_{EB0} = 0.5$ V, $f = 1$ MHz		
Thermal resistance		
Junction to case	$R_{th C}$	< 35 °C/W
Junction to ambient air	$R_{th A}$	< 200 °C/W
Switching Times at $I_C = 100$ mA, $I_{B1} \approx -I_{B2} \approx 5$ mA		
Turn-on time	t_{on}	< 250 ns
Turn-off time	t_{off}	< 850 ns

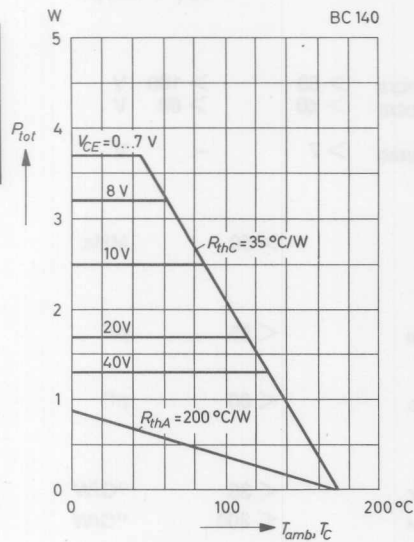
Test Circuit for Switching Times



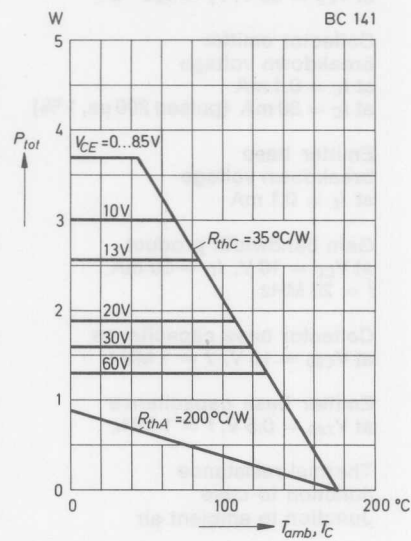
Rise time and fall time of input voltage < 15 ns,
generator impedance 50 Ω

BC 140, BC 141

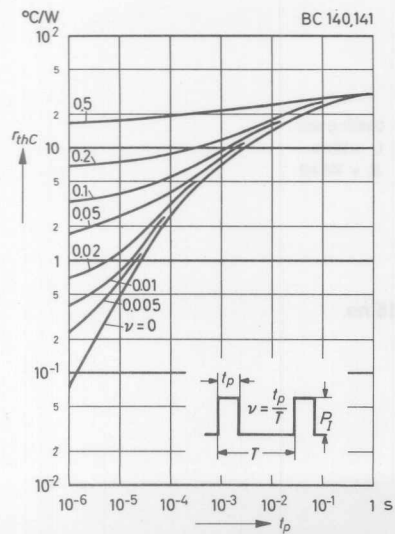
Admissible power dissipation
versus temperature



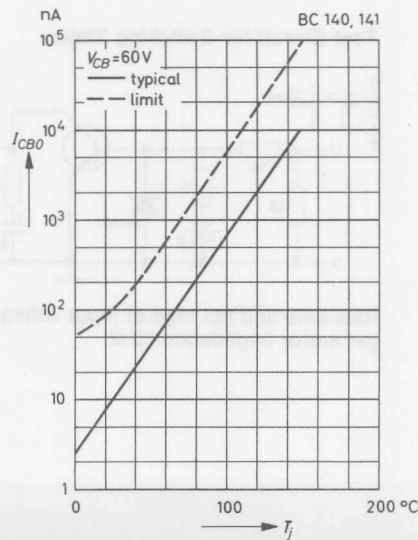
Admissible power dissipation
versus temperature



Pulse thermal resistance
versus pulse duration

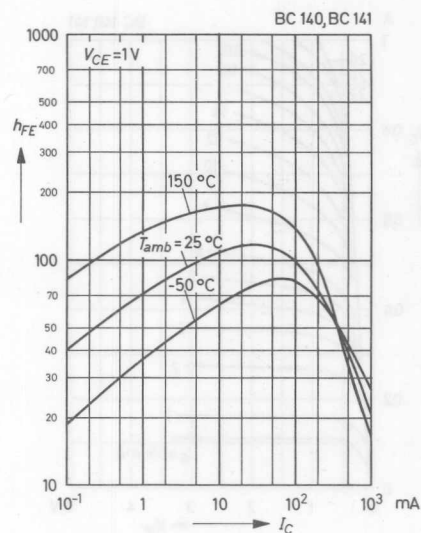


Collector cutoff current
versus junction temperature

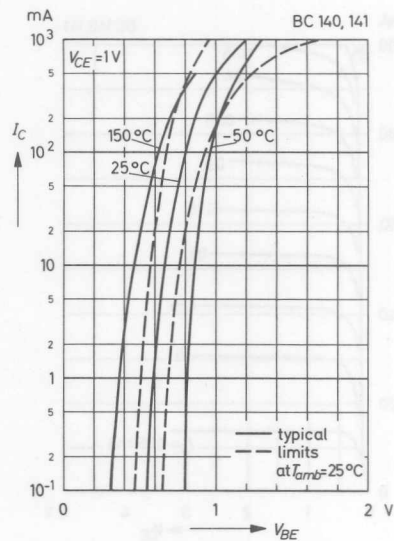


BC 140, BC 141

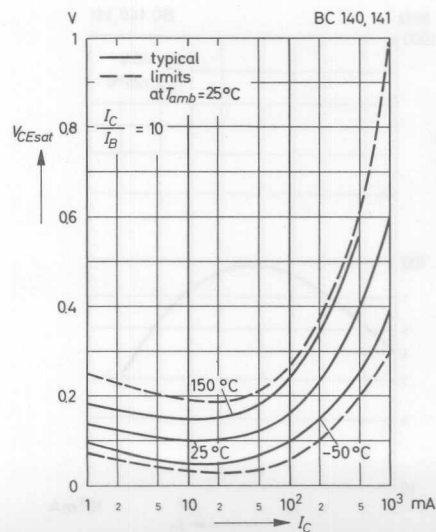
**DC current gain
versus collector current**



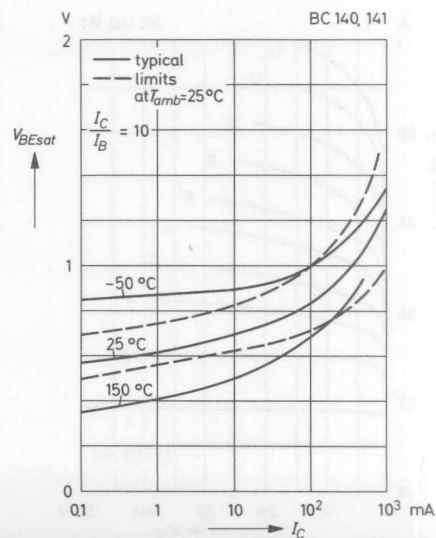
**Collector current
versus base emitter voltage**



**Collector saturation voltage
versus collector current**

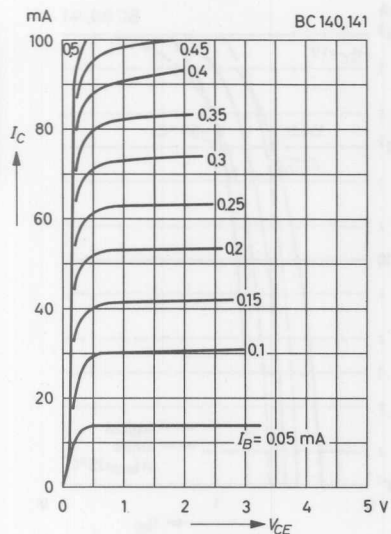


**Base saturation voltage
versus collector current**

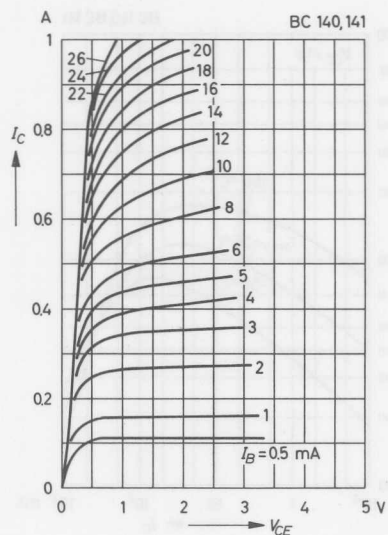


BC 140, BC 141

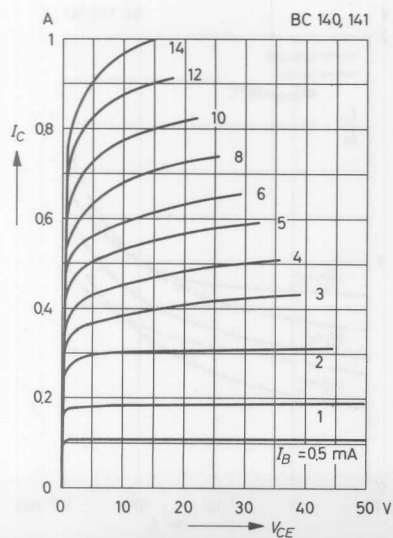
**Common emitter
collector characteristics**



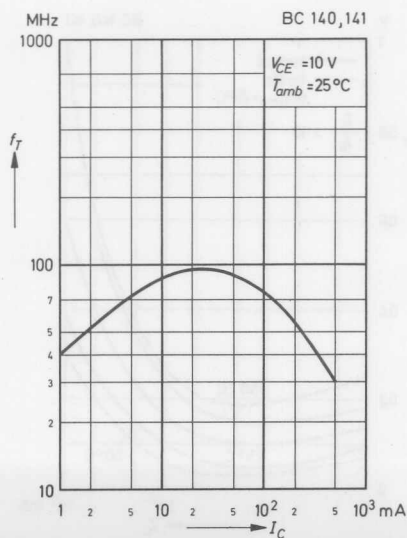
**Common emitter
collector characteristics**



**Common emitter
collector characteristics**



**Gain bandwidth product
versus collector current**



The transistors are subdivided into three groups A, B and C according to their DC current gain.

NOTE: Silicon Planar Transistor for switching and amplifier applications.



Package dimensions - JEDEC TO-18
 TO-18 dimensions
 The data is representative in mm
 Weight approximately 0.15 g
 Dimensions in mm

Maximum ratings		
Collector base voltage	V_{CB}	30 V
Collector emitter voltage	V_{CE}	30 V
Emitter base voltage	V_{EB}	5 V
Collector current	I_C	100 mA
Power dissipation	P_{tot}	200 mW
at $T_{amb} = 25^\circ\text{C}$		
Junction temperature	T_j	150 $^\circ\text{C}$
Storage temperature range	T_s	-55 ... +125 $^\circ\text{C}$

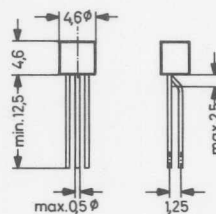
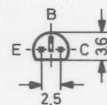
Characteristics at $T_{amb} = 25^\circ\text{C}$	BC 140 A	BC 140 B	BC 140 C
DC current gain			
at $V_{CE} = 1\text{ V}$, $I_C = 1\text{ mA}$	$h_{FE} \geq 100$	$h_{FE} \geq 100$	$h_{FE} \geq 100$
at $V_{CE} = 1\text{ V}$, $I_C = 10\text{ mA}$	$h_{FE} \geq 50$	$h_{FE} \geq 50$	$h_{FE} \geq 50$
Collector saturation voltage			
at $I_C = 1\text{ mA}$, $V_{BE} = 0.7\text{ V}$	$V_{CE(sat)} < 0.2\text{ V}$	$V_{CE(sat)} < 0.2\text{ V}$	$V_{CE(sat)} < 0.2\text{ V}$
at $I_C = 10\text{ mA}$, $V_{BE} = 0.7\text{ V}$	$V_{CE(sat)} < 0.2\text{ V}$	$V_{CE(sat)} < 0.2\text{ V}$	$V_{CE(sat)} < 0.2\text{ V}$
Base saturation voltage			
at $I_C = 1\text{ mA}$, $V_{CE} = 0.1\text{ V}$	$V_{BE(sat)} < 0.7\text{ V}$	$V_{BE(sat)} < 0.7\text{ V}$	$V_{BE(sat)} < 0.7\text{ V}$
Collector small signal			
at $V_{CE} = 1\text{ V}$	$f_{max} > 0.1\text{ GHz}$	$f_{max} > 0.1\text{ GHz}$	$f_{max} > 0.1\text{ GHz}$

Values measured from leads are kept at ambient temperature at a distance of 2 mm from case.

BC 170

NPN Silicon Planar Transistor for switching and amplifier applications

The transistors are subdivided into three groups, A, B and C, according to their DC current gain.



Plastic package \approx JEDEC TO-92,
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

Maximum Ratings

Collector base voltage	V_{CB0}	20	V
Collector emitter voltage	V_{CE0}	20	V
Emitter base voltage	V_{EB0}	5	V
Collector current	I_C	100	mA
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}	300 ¹	mW
Junction temperature	T_j	150	$^\circ\text{C}$
Storage temperature range	T_s	$-55 \dots +150$	$^\circ\text{C}$

Characteristics at $T_{amb} = 25^\circ\text{C}$

	BC 170 A	BC 170 B	BC 170 C
DC current gain			
at $V_{CE} = 1\text{ V}, I_C = 1\text{ mA}$	$h_{FE} \ 35 \dots 100$	$80 \dots 250$	$200 \dots 600$
at $V_{CE} = 1\text{ V}, I_C = 30\text{ mA}$	$h_{FE} > 30$	> 60	> 150
Collector saturation voltage			
at $I_C = 1\text{ mA}, I_B = 0.1\text{ mA}$	$V_{CE\ sat}$	< 0.25	V
at $I_C = 30\text{ mA}, I_B = 3\text{ mA}$	$V_{CE\ sat}$	< 0.4	V
Base saturation voltage			
at $I_C = 1\text{ mA}, I_B = 0.1\text{ mA}$	$V_{BE\ sat}$	< 0.7	V
Collector cutoff current at $V_{CB} = 15\text{ V}$	I_{CB0}	< 0.1	μA

¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

Emitter cutoff current
at $V_{EB} = 4 \text{ V}$

$I_{EBO} < 0.1 \mu\text{A}$

Collector base capacitance
at $V_{CB0} = 10 \text{ V}, f = 1 \text{ MHz}$

$C_{CB0} 4 \text{ pF}$

Emitter base capacitance
at $V_{EB0} = 0.5 \text{ V}, f = 1 \text{ MHz}$

$C_{EB0} 12 \text{ pF}$

Gain bandwidth product
at $V_{CE} = 5 \text{ V}, I_C = 10 \text{ mA},$
 $f = 50 \text{ MHz}$

$f_T 100 \text{ MHz}$

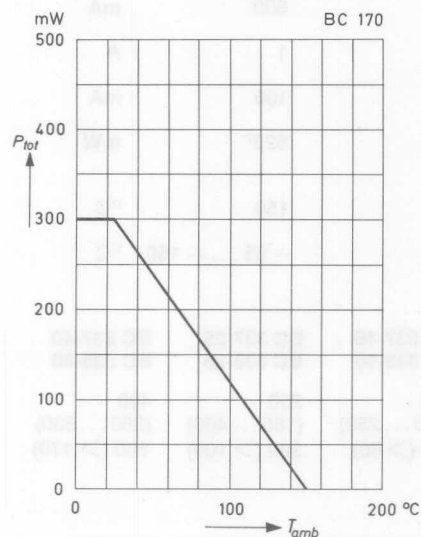
Noise figure at $V_{CE} = 5 \text{ V},$
 $I_C = 0.2 \text{ mA}, R_G = 2 \text{ k}\Omega,$
 $f = 1 \text{ kHz}, \Delta f = 200 \text{ Hz}$

$F < 10 \text{ dB}$

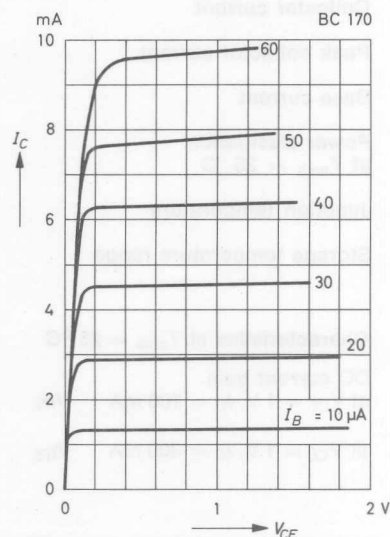
Thermal resistance
Junction to ambient air

$R_{thA} < 420^1 \text{ }^\circ\text{C/W}$

Admissible power dissipation
versus ambient temperature¹



Common emitter
collector characteristics



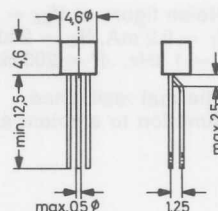
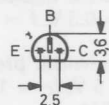
¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

BC 337, BC 338

NPN Silicon Epitaxial Planar Transistors

for switching and amplifier applications. Especially suitable for AF-driver stages and low power output stages.

These types are subdivided into three groups -16, -25 and -40, according to their DC current gain. As complementary types the PNP transistors BC 327 and BC 328 are recommended.



Plastic case \approx JEDEC TO-92
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

Maximum Ratings

		BC 337	BC 338	
Collector emitter voltage	V_{CES}	50	30	V
Collector emitter voltage	V_{CE0}	45	25	V
Emitter base voltage	V_{EB0}	5		V
Collector current	I_C	800		mA
Peak collector current	I_{CM}	1		A
Base current	I_B	100		mA
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{Tot}	625 ¹		mW
Junction temperature	T_j	150		$^\circ\text{C}$
Storage temperature range	T_S	$-55 \dots +150$		$^\circ\text{C}$

Characteristics at $T_{amb} = 25^\circ\text{C}$

		BC 337-16 BC 338-16	BC 337-25 BC 338-25	BC 337-40 BC 338-40
DC current gain at $V_{CE} = 1\text{ V}$, $I_C = 100\text{ mA}$	h_{FE}	160 (100 ... 250)	250 (160 ... 400)	400 (250 ... 630)
at $V_{CE} = 1\text{ V}$, $I_C = 300\text{ mA}$	h_{FE}	130 (> 60)	200 (> 100)	300 (> 170)

¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

BC 337, BC 338

Collector cutoff current

at $V_{CE} = 25 \text{ V}$

at $V_{CE} = 45 \text{ V}$

at $V_{CE} = 25 \text{ V}, T_{amb} = 125^\circ\text{C}$

at $V_{CE} = 45 \text{ V}, T_{amb} = 125^\circ\text{C}$

Collector emitter breakdown voltage at $I_C = 10 \text{ mA}$

Collector emitter breakdown voltage at $I_C = 0.1 \text{ mA}$

Emitter base breakdown voltage at $I_E = 0.1 \text{ mA}$

Collector saturation voltage at $I_C = 500 \text{ mA}, I_B = 50 \text{ mA}$

Base emitter voltage at $V_{CE} = 1 \text{ V}, I_C = 300 \text{ mA}$

Gain bandwidth product at $V_{CE} = 5 \text{ V}, I_C = 10 \text{ mA}, f = 50 \text{ MHz}$

Collector base capacitance at $V_{CB} = 10 \text{ V}, f = 1 \text{ MHz}$

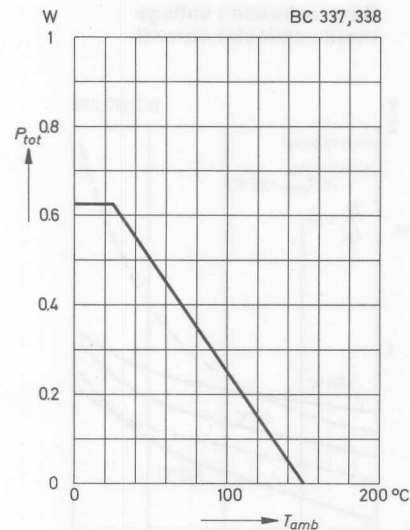
Thermal resistance Junction to ambient air

BC 337

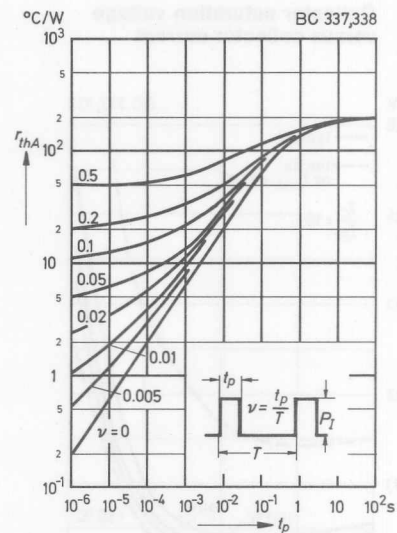
BC 338

I_{CES}	—	2 (< 100)	nA
I_{CES}	2 (< 100)	—	nA
I_{CES}	—	< 10	μA
I_{CES}	< 10	—	μA
$V_{(BR)CEO}$	> 45	> 20	V
$V_{(BR)CES}$	> 50	> 30	V
$V_{(BR)EB0}$	> 5		V
$V_{CE sat}$	< 0,7		V
V_{BE}	< 1,2		V
f_T	100		MHz
C_{CB0}	12		pF
R_{thA}	< 200 ¹		$^\circ\text{C/W}$

Admissible power dissipation versus ambient temperature¹⁾



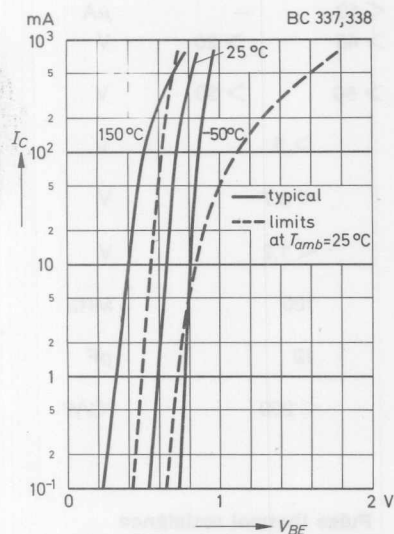
Pulse thermal resistance versus pulse duration¹⁾



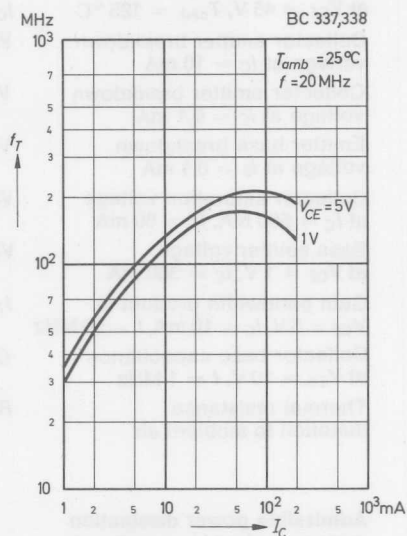
¹⁾ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

BC 337, BC 338

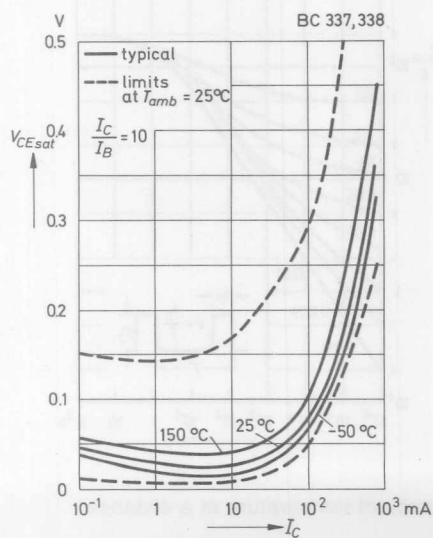
Collector current
versus base emitter voltage



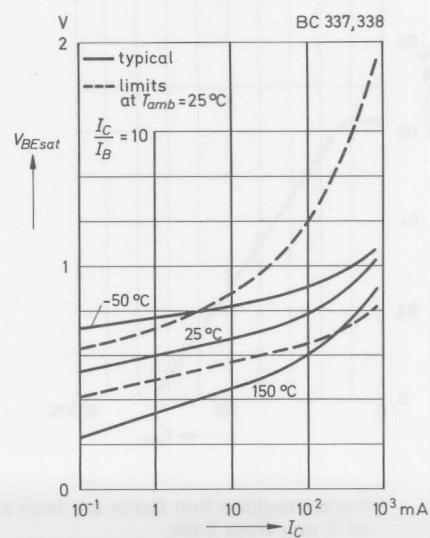
Gain bandwidth product
versus collector current



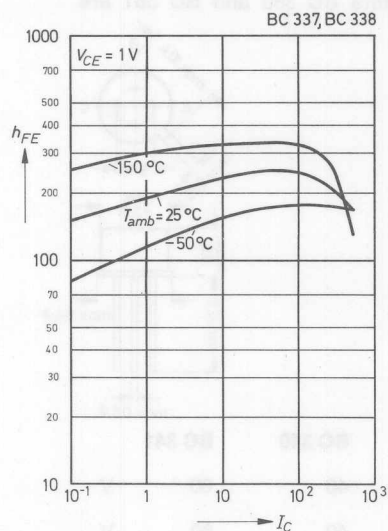
Collector saturation voltage
versus collector current



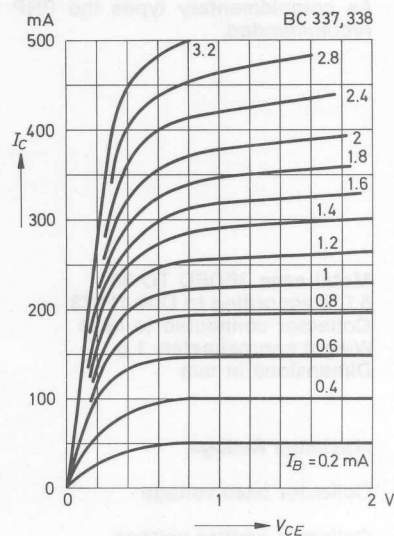
Base saturation voltage
versus collector current



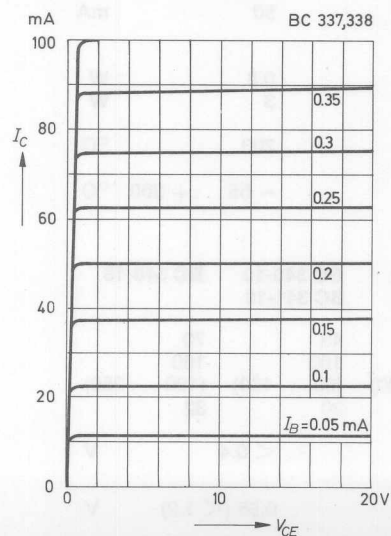
**DC current gain
versus collector current**



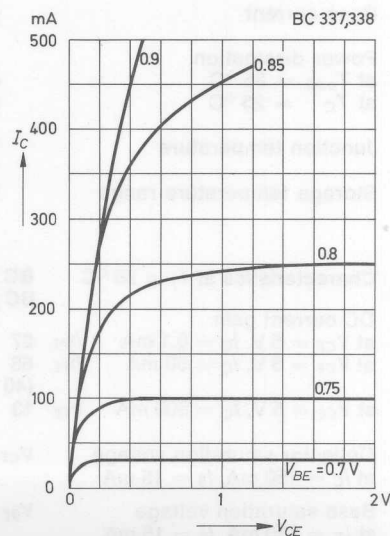
**Common emitter
collector characteristics**



**Common emitter
collector characteristics**



**Common emitter
collector characteristics**



BC 340, BC 341

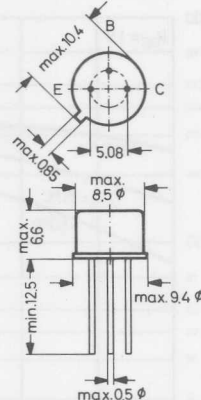
NPN Silicon Epitaxial Planar Transistors

for switching and amplifier applications

The type BC 340 is subdivided into three groups, -6, -10 and -16, the type BC 341 into two groups, -6 and -10, according to the DC current gain.

As complementary types the PNP transistors BC 360 and BC 361 are recommended.

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

		BC 340	BC 341	
Collector base voltage	V_{CB0}	40	60	V
Collector emitter voltage	V_{CE0}	40	60	V
Emitter base voltage	V_{EB0}	5	5	V
Collector current	I_C	500		mA
Base current	I_B	50		mA
Power dissipation				
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8		W
at $T_C = 25^\circ\text{C}$	P_{tot}	3		W
Junction temperature	T_j	200		$^\circ\text{C}$
Storage temperature range	T_S	- 55 ... + 200		$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

	BC 340-6 BC 341-6	BC 340-10 BC 341-10	BC 340-16
DC current gain			
at $V_{CE} = 5\text{ V}, I_C = 0.1\text{ mA}$	h_{FE} 27	43	70
at $V_{CE} = 5\text{ V}, I_C = 50\text{ mA}$	h_{FE} 63 (40 ... 100)	100 (63 ... 160)	160 (100 ... 250)
at $V_{CE} = 5\text{ V}, I_C = 500\text{ mA}$	h_{FE} 13	20	32
Collector saturation voltage	$V_{CE\text{ sat}}$	< 0.4	V
at $I_C = 150\text{ mA}, I_B = 15\text{ mA}$			
Base saturation voltage	$V_{BE\text{ sat}}$	0.95 (< 1.2)	V
at $I_C = 150\text{ mA}, I_B = 15\text{ mA}$			

BC 340, BC 341

Collector cutoff current

at $V_{CE} = 40$ V
 at $V_{CE} = 60$ V
 at $V_{CE} = 40$ V, $T_j = 150$ °C
 at $V_{CE} = 60$ V, $T_j = 150$ °C

I_{CES}
 I_{CES}
 I_{CES}
 I_{CES}

BC 340

10 (< 100)
 —
 10 (< 100)
 —

BC 341

—
 10 (< 100)
 —
 10 (< 100)

nA
 nA
 μ A
 μ A

Collector emitter breakdown voltage

at $I_C = 0.1$ mA
 at $I_C = 30$ mA
 (pulsed 200 μ s, 1 %)

$V_{(BR)CES}$
 $V_{(BR)CEO}$

> 40
 > 40

> 60
 > 60

V
 V

Gain bandwidth product

at $V_{CE} = 10$ V, $I_C = 50$ mA,
 $f = 50$ MHz

f_T

100

MHz

Collector base capacitance

at $V_{CB0} = 10$ V, $f = 1$ MHz

C_{CB0}

6.5

pF

Emitter base capacitance

at $V_{EB0} = 0.5$ V, $f = 1$ MHz

C_{EB0}

25

pF

Thermal resistance

Junction to ambient air
 Junction to case

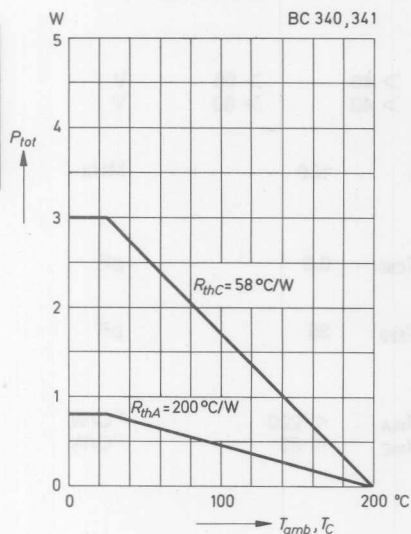
R_{thA}
 R_{thC}

< 220
 < 58

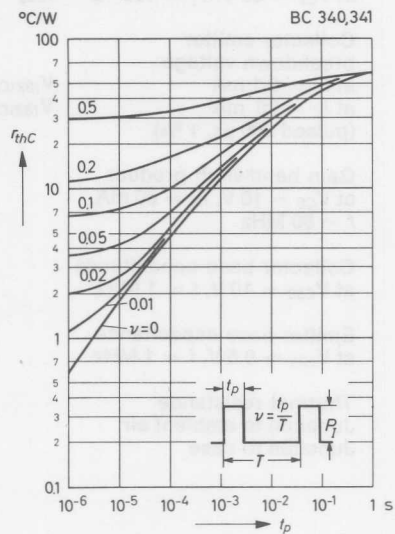
°C/W
 °C/W

BC 340, BC 341

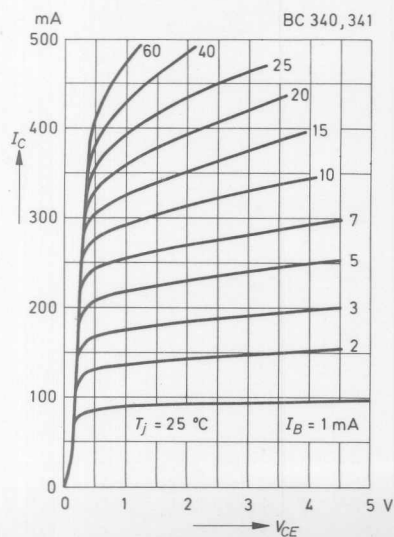
**Admissible power dissipation
versus temperature**



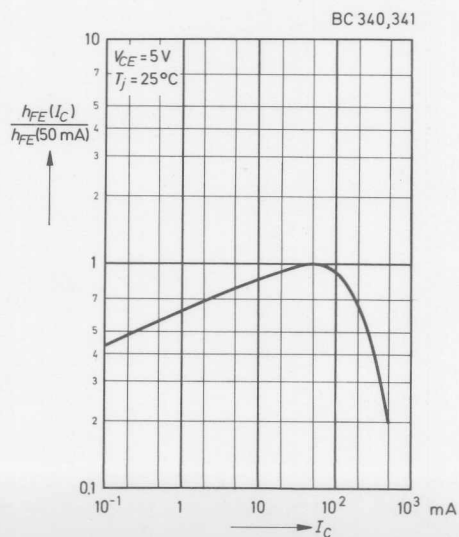
**Pulse thermal resistance
versus pulse duration**



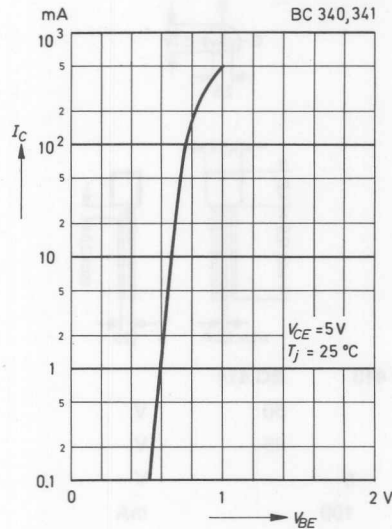
**Common emitter
collector characteristics**



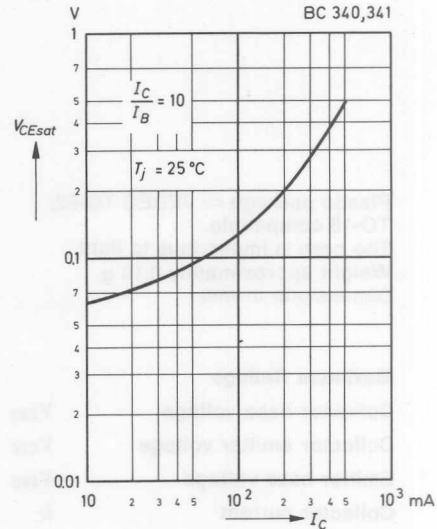
**Relative DC current gain
versus collector current**



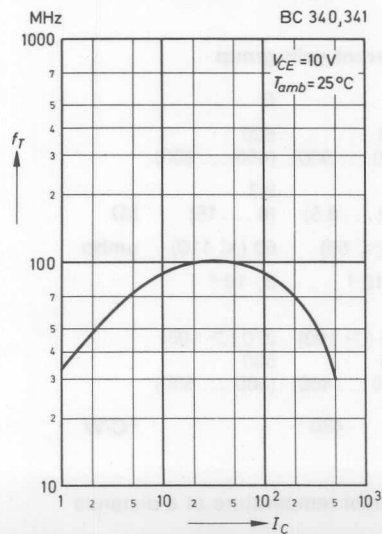
**Collector current
versus base emitter voltage**



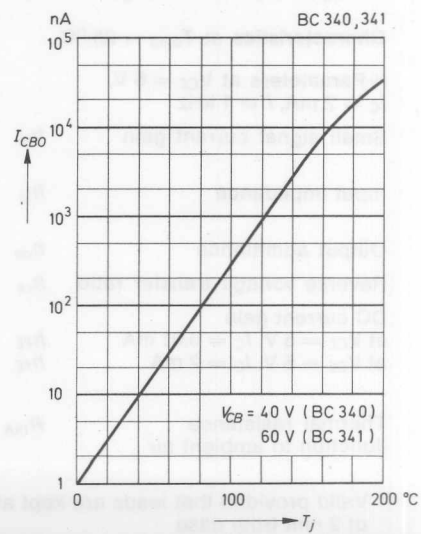
**Collector saturation voltage
versus collector current**



**Gain bandwidth product
versus collector current**



**Collector cutoff current
versus junction temperature**



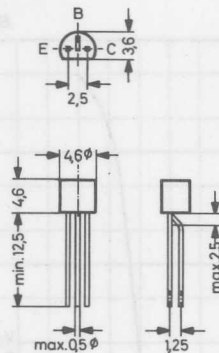
BC 413, BC 414

NPN Silicon Epitaxial Planar Transistors

for use in high-quality, low-noise AF and DC amplifiers. Complementary types are the PNP transistors BC 415 and BC 416.

These types are subdivided into two groups B and C according to their current gain.

Plastic package \approx JEDEC TO-92,
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm



Maximum Ratings

	BC 413	BC 414	
Collector base voltage	V_{CB0} 45	50	V
Collector emitter voltage	V_{CE0} 30	45	V
Emitter base voltage	V_{EB0} 5		V
Collector current	I_C 100		mA
Base current	I_B 20		mA
Power dissipation at $T_{amb}=25^\circ\text{C}$	P_{tot} 300 ¹		mW
Junction temperature	T_j 150		$^\circ\text{C}$
Storage temperature range	T_S -65 ... +150		$^\circ\text{C}$

Characteristics at $T_{amb} = 25^\circ\text{C}$

h -Parameters at $V_{CE} = 5\text{ V}$,
 $I_C = 2\text{ mA}$, $f = 1\text{ kHz}$

		B	C	
Small signal current gain	h_{fe}	330 (240 ... 500)	600 (450 ... 900)	
Input impedance	h_{ie}	4.5 (3.2 ... 8.5)	8.7 (6 ... 15)	k Ω
Output admittance	h_{oe}	30 (< 60)	60 (< 110)	μmho
Reverse voltage transfer ratio	h_{re}	$2 \cdot 10^{-4}$	$3 \cdot 10^{-4}$	
DC current gain				
at $V_{CE} = 5\text{ V}$, $I_C = 0.01\text{ mA}$	h_{FE}	150 (> 100)	270 (> 100)	
at $V_{CE} = 5\text{ V}$, $I_C = 2\text{ mA}$	h_{FE}	290 (180 ... 460)	500 (380 ... 800)	
Thermal resistance	R_{thA}	420 ¹		$^\circ\text{C/W}$
Junction to ambient air				

¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case

Collector saturation voltage
at $I_C = 10 \text{ mA}$, $I_B = 0.5 \text{ mA}$
at $I_C = 100 \text{ mA}$, $I_B = 5 \text{ mA}$

$V_{CE \text{ sat}}$ 0.075 (< 0.25) V
 $V_{CE \text{ sat}}$ 0.25 (< 0.6) V

Base saturation voltage
at $I_C = 100 \text{ mA}$, $I_B = 5 \text{ mA}$

$V_{BE \text{ sat}}$ 0.9 V

Base emitter voltage
at $V_{CE} = 5 \text{ V}$, $I_C = 0.01 \text{ mA}$
at $V_{CE} = 5 \text{ V}$, $I_C = 0.1 \text{ mA}$
at $V_{CE} = 5 \text{ V}$, $I_C = 2 \text{ mA}$

V_{BE} 0.52 V
 V_{BE} 0.55 V
 V_{BE} 0.62 (0.55 ... 0.75) V

Collector cutoff current
at $V_{CB} = 30 \text{ V}$
at $V_{CB} = 30 \text{ V}$, $T_{amb} = 150^\circ\text{C}$

I_{CB0} < 15 nA
 I_{CB0} < 5 μA

Emitter cutoff current
at $V_{EB} = 4 \text{ V}$

I_{EB0} < 15 nA

BC 413 BC 414

Collector emitter breakdown
voltage at $I_C = 10 \text{ mA}$

$V_{(BR)CEO}$ > 30 > 45 V

Collector base breakdown
voltage at $I_C = 10 \mu\text{A}$

$V_{(BR)CBO}$ > 45 > 50 V

Emitter base breakdown
voltage at $I_E = 10 \mu\text{A}$

$V_{(BR)EBO}$ > 5 > 5 V

Gain bandwidth product
at $V_{CE} = 5 \text{ V}$, $I_C = 10 \text{ mA}$,
 $f = 100 \text{ MHz}$

f_T 250 MHz

Collector base capacitance
at $V_{CB0} = 10 \text{ V}$, $f = 1 \text{ MHz}$

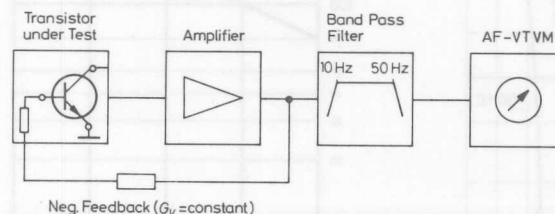
C_{CB0} 2.5 pF

Noise figure
at $V_{CE} = 5 \text{ V}$, $I_C = 0.2 \text{ mA}$,
 $R_G = 2 \text{ k}\Omega$, $f = 30 \text{ Hz} \dots 15 \text{ kHz}$

F < 3 dB

Equivalent noise EMF
(referred to base)
at $V_{CE} = 5 \text{ V}$, $I_C = 0.2 \text{ mA}$,
 $R_G = 2 \text{ k}\Omega$, $f = 10 \dots 50 \text{ Hz}$

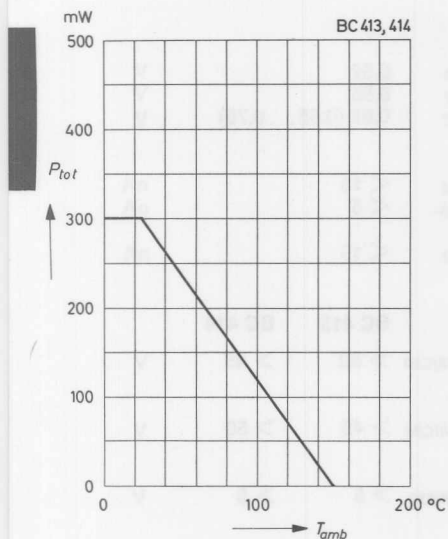
v_r < 0.135 μV



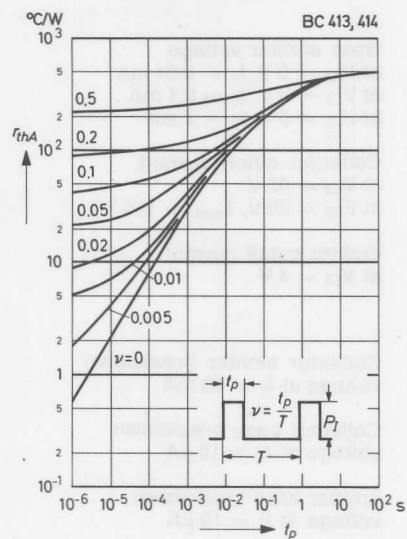
Test circuit for equivalent noise EMF

BC 413, BC 414

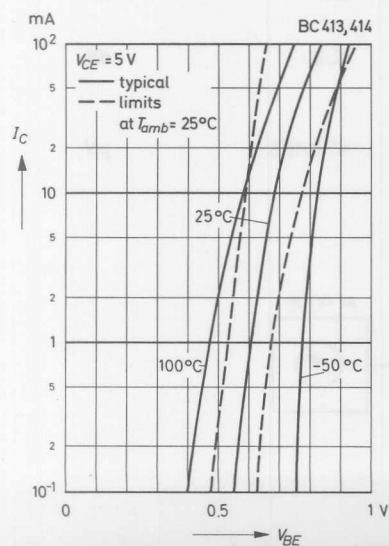
**Admissible power dissipation
versus ambient temperature**
(see note on page 58)



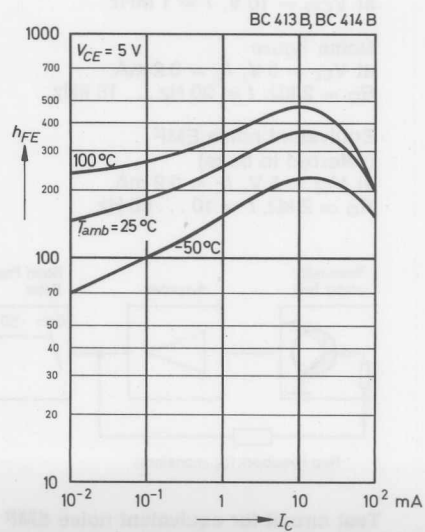
**Pulse thermal resistance
versus pulse duration**
(see note on page 58)



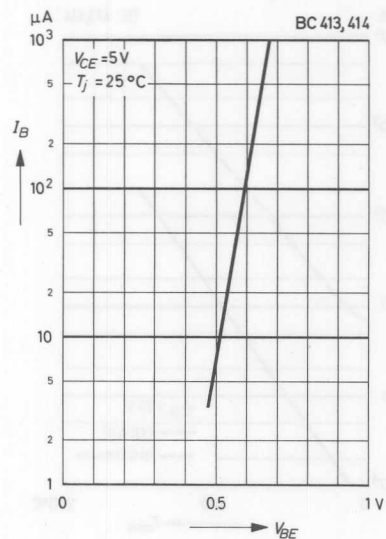
**Collector current
versus base emitter voltage**



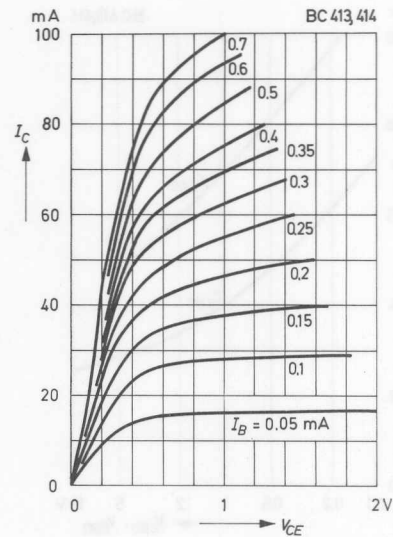
**DC current gain
versus collector current**



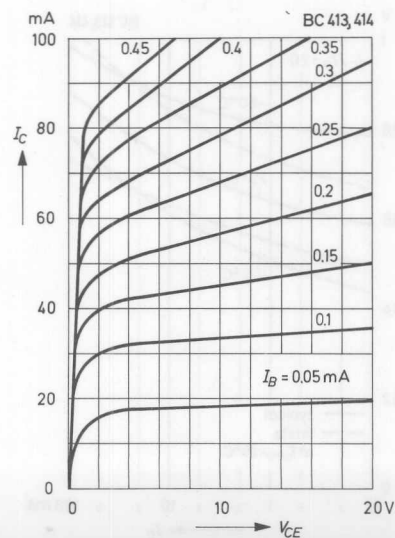
**Common emitter
input characteristic**



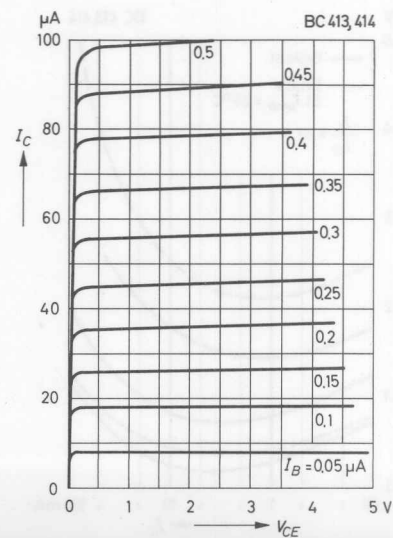
**Common emitter
collector characteristics**



**Common emitter
collector characteristics**

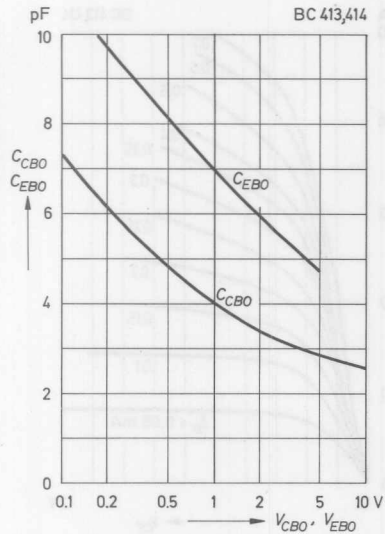


**Common emitter
collector characteristics**

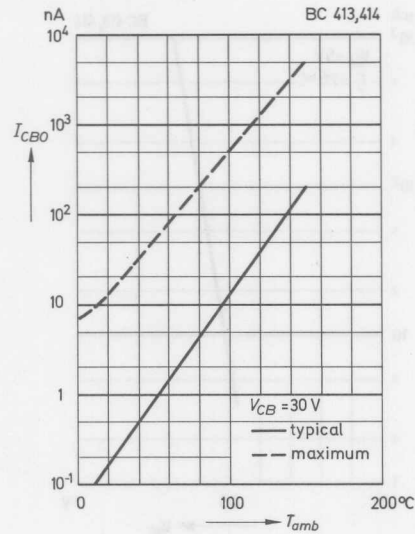


BC 413, BC 414

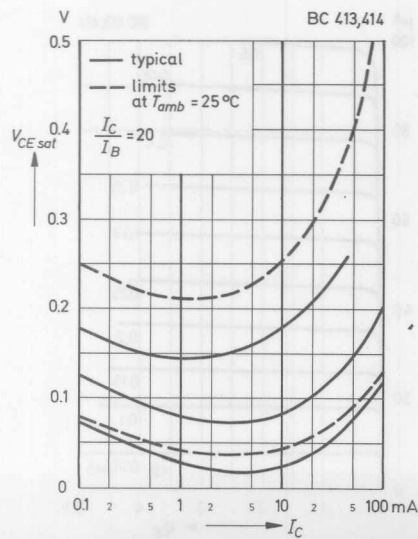
**Collector base capacitance,
Emitter base capacitance
versus reverse bias voltage**



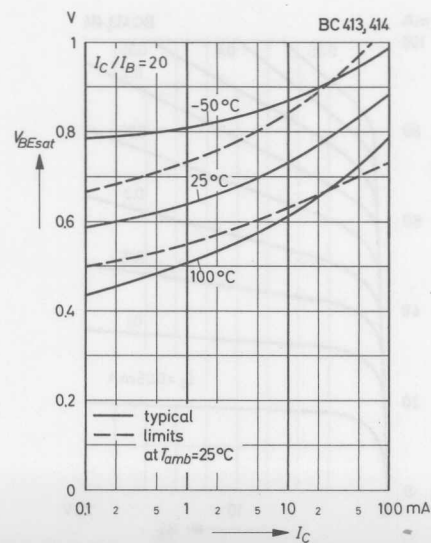
**Collector cutoff current
versus ambient temperature**



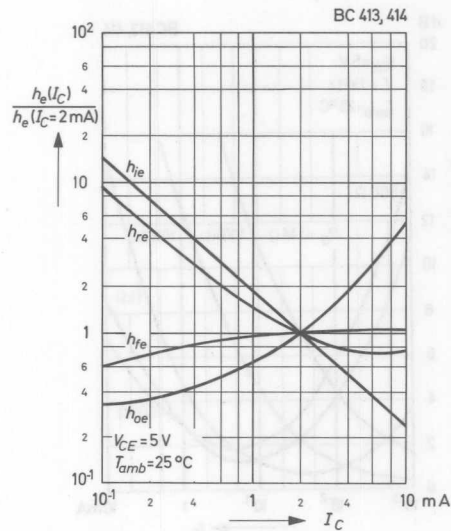
**Collector saturation voltage
versus collector current**



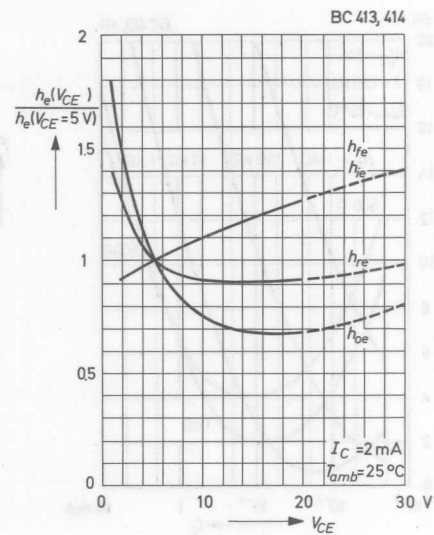
**Base saturation voltage
versus collector current**



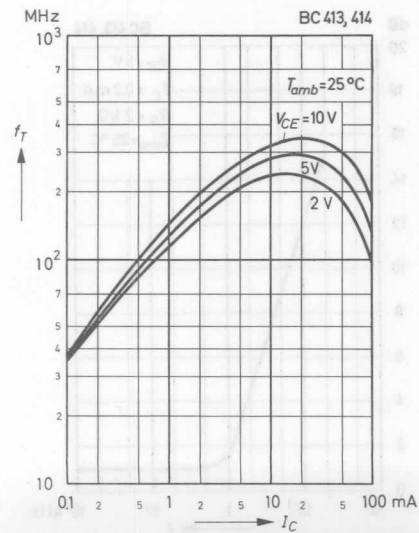
**Relative h -parameters
versus
collector current**



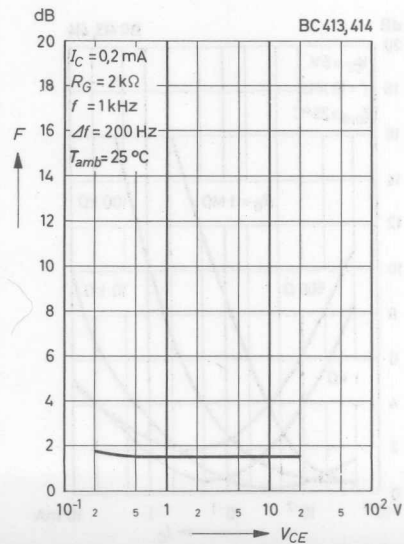
**Relative h -parameters
versus
collector emitter voltage**



**Gain bandwidth product
versus
collector current**

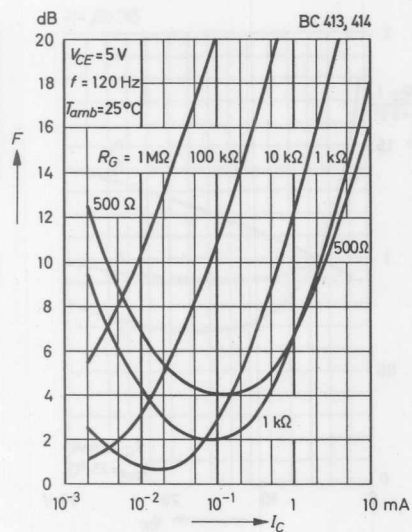


**Noise figure versus
collector emitter voltage**

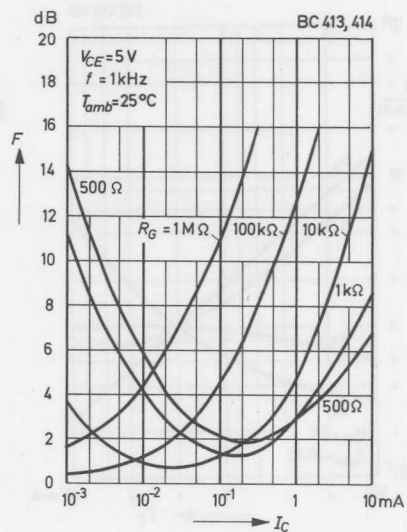


BC 413, BC 414

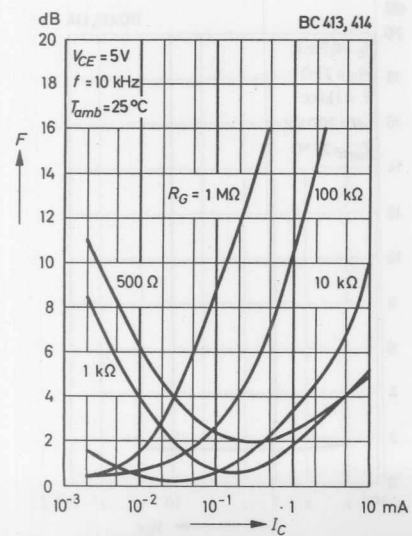
Noise figure
versus collector current



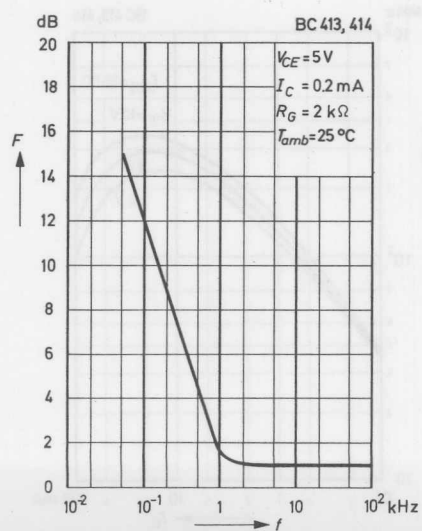
Noise figure
versus collector current



Noise figure
versus collector current



Noise figure
versus frequency



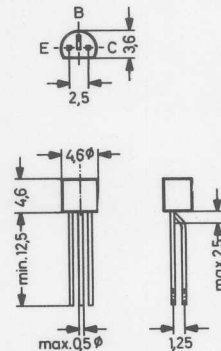
BC 546 ... BC 550

NPN Silicon Epitaxial Planar Transistors

for switching and AF amplifier applications.

These transistors are subdivided into three groups A, B and C according to their current gain. The types BC 546 and BC 547 are available in groups A and B, however, type BC 548 can be supplied in all three groups. The BC 549 and BC 550 are low noise types and available in groups B and C. As complementary types the PNP transistors BC 556 ... BC 560 are recommended.

Plastic package \approx JEDEC TO-92
TO-18 compatible
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm



Maximum Ratings

		BC 546	BC 547 BC 550	BC 548 BC 549	
Collector base voltage	V_{CB0}	80	50	30	V
Collector emitter voltage	V_{CES}	80	50	30	V
Collector emitter voltage	V_{CE0}	65	45	30	V
Emitter base voltage	V_{EB0}	6	6 ¹⁾	5	V
Collector current	I_C	100	100	100	mA
Peak collector current	I_{CM}	200	200	200	mA
Peak base current	I_{BM}	200	200	200	mA
Peak emitter current	$-I_{EM}$	200	200	200	mA
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}		500 ²⁾		mW
Junction temperature	T_j		150		$^\circ\text{C}$
Storage temperature range	T_S		- 65 ... +150		$^\circ\text{C}$

¹⁾ BC 550: $V_{EB0} = 5$ V

²⁾ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

Characteristics at $T_{amb} = 25\text{ }^{\circ}\text{C}$ **h -Parameters at $V_{CE} = 5\text{ V}$,
 $I_C = 2\text{ mA}$, $f = 1\text{ kHz}$** **Current Gain Group****A B C**

Current gain	h_{fe}	220 (125...260)	330 (240...500)	600 (450...900)	
Input impedance	h_{ie}	2.7 (1.6...4.5)	4.5 (3.2...8.5)	8.7 (6...15)	k Ω
Output admittance	h_{oe}	18 (< 30)	30 (< 60)	60 (< 110)	μmho
Reverse voltage transfer ratio	h_{re}	$1.5 \cdot 10^{-4}$	$2 \cdot 10^{-4}$	$3 \cdot 10^{-4}$	
DC current gain					
at $V_{CE} = 5\text{ V}$, $I_C = 10\text{ }\mu\text{A}$	h_{FE}	90	150	270	
at $V_{CE} = 5\text{ V}$, $I_C = 2\text{ mA}$	h_{FE}	180	290	500	
at $V_{CE} = 5\text{ V}$, $I_C = 100\text{ mA}$	h_{FE}	120	200	400	
Thermal resistance Junction to ambient air	R_{thA}		< 250 ¹⁾		$^{\circ}\text{C/W}$
Collector saturation voltage					
at $I_C = 10\text{ mA}$, $I_B = 0.5\text{ mA}$	$V_{CE\text{ sat}}$		90 (< 250)		mV
at $I_C = 100\text{ mA}$, $I_B = 5\text{ mA}$	$V_{CE\text{ sat}}$		200 (< 600)		mV
Base saturation voltage					
at $I_C = 10\text{ mA}$, $I_B = 0.5\text{ mA}$	$V_{BE\text{ sat}}$		700		mV
at $I_C = 100\text{ mA}$, $I_B = 5\text{ mA}$	$V_{BE\text{ sat}}$		900		mV
Base emitter voltage					
at $V_{CE} = 5\text{ V}$, $I_C = 2\text{ mA}$	V_{BE}		660 (580 ... 700)		mV
at $V_{CE} = 5\text{ V}$, $I_C = 10\text{ mA}$	V_{BE}		< 720		mV
Collector cutoff current					
at $V_{CB} = 30\text{ V}$	I_{CB0}		< 15		nA
at $V_{CB} = 30\text{ V}$, $T_j = 150\text{ }^{\circ}\text{C}$	I_{CB0}		< 5		μA
Gain bandwidth product	f_T		300		MHz
at $V_{CE} = 5\text{ V}$, $I_C = 10\text{ mA}$, $f = 100\text{ MHz}$					
Collector base capacitance	C_{CB0}		3.5 (< 6)		pF
at $V_{CB} = 10\text{ V}$, $f = 1\text{ MHz}$					
Emitter base capacitance	C_{EB0}		9		pF
at $V_{EB} = 0.5\text{ V}$, $f = 1\text{ MHz}$					

¹⁾ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

BC 546 ... BC 550

BC 546
BC 547
BC 548

BC 549
BC 550

Noise figure

at $V_{CE} = 5 \text{ V}$, $I_C = 200 \text{ } \mu\text{A}$,
 $R_G = 2 \text{ k}\Omega$, $f = 1 \text{ kHz}$, $\Delta f = 200 \text{ Hz}$

F

2 (< 10) 1.2 (< 4) dB

Noise figure

at $V_{CE} = 5 \text{ V}$, $I_C = 200 \text{ } \mu\text{A}$,
 $R_G = 2 \text{ k}\Omega$, $f = 30 \dots 15\,000 \text{ Hz}$

F

BC 549 BC 550
1.4 (< 4) 1.4 (< 3) dB

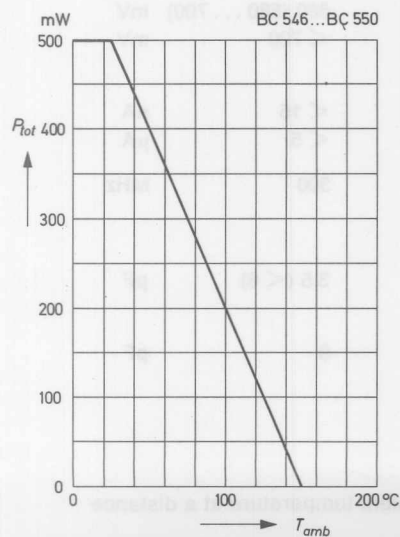
Equivalent noise EMF

at $V_{CE} = 5 \text{ V}$, $I_C = 200 \text{ } \mu\text{A}$,
 $R_G = 2 \text{ k}\Omega$, $f = 10 \dots 50 \text{ Hz}$

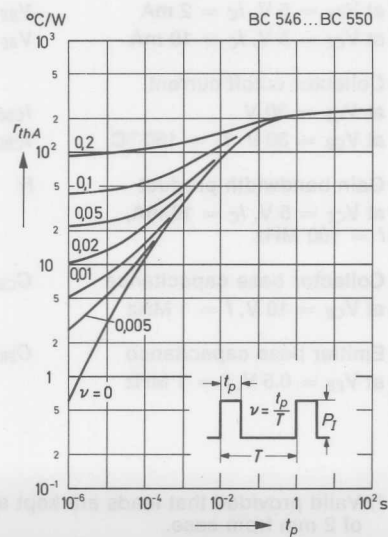
v_r

— < 0.135 μV

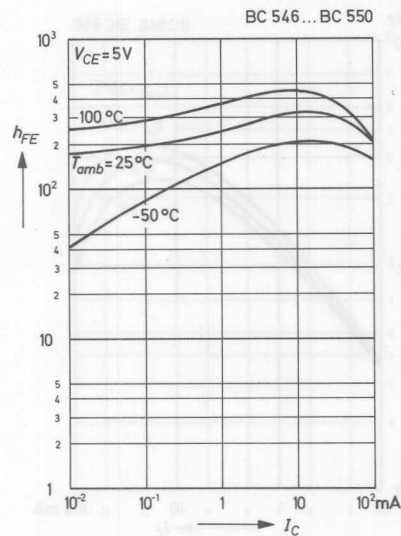
**Admissible power dissipation
versus temperature**
(see note page 67)



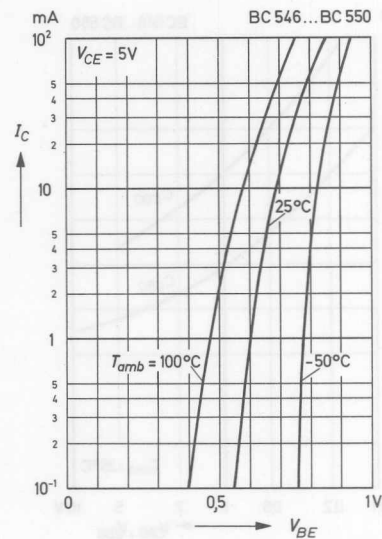
**Pulse thermal resistance
versus pulse duration**
(see note page 67)



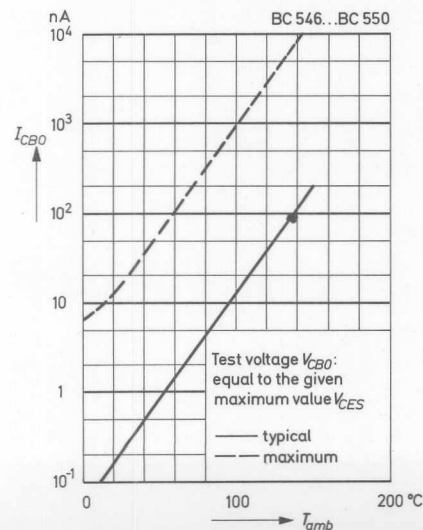
**DC current gain
versus collector current**



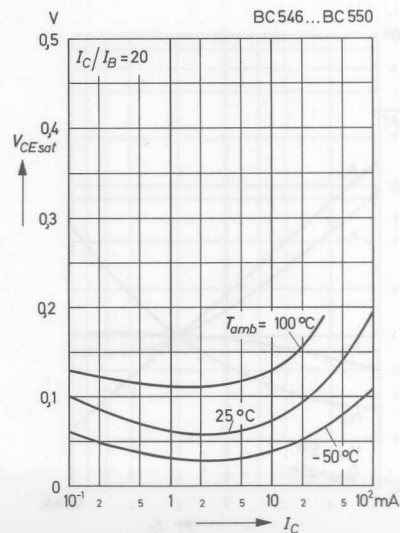
**Collector current versus
base emitter voltage**



**Collector cutoff current
versus ambient temperature**

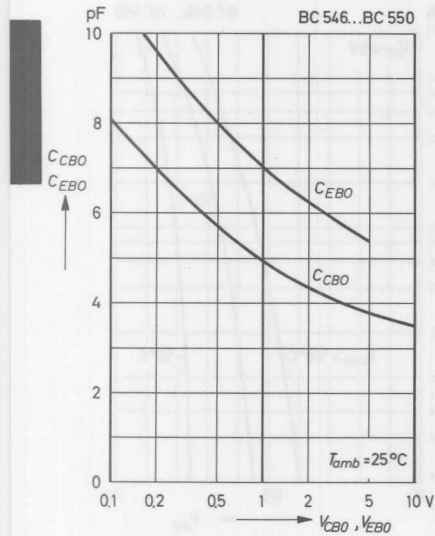


**Collector saturation voltage
versus collector current**

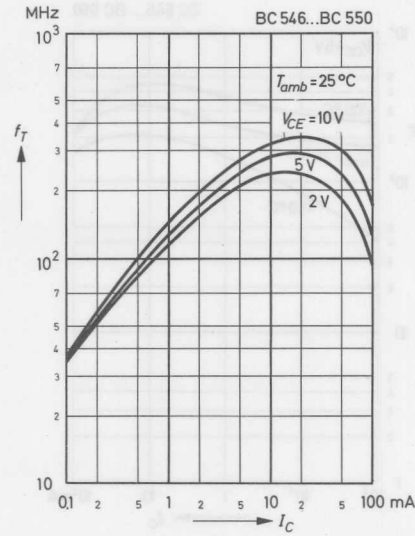


BC 546 ... BC 550

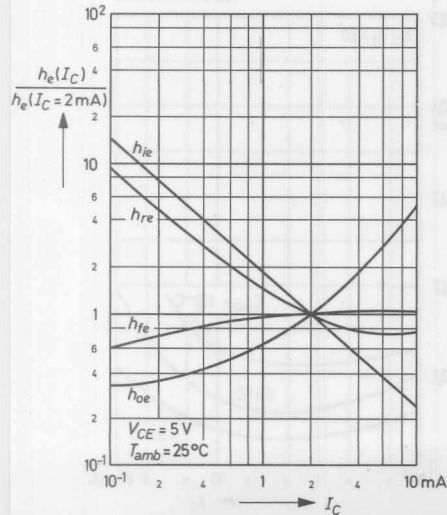
Collector base capacitance,
Emitter base capacitance
versus reverse bias voltage



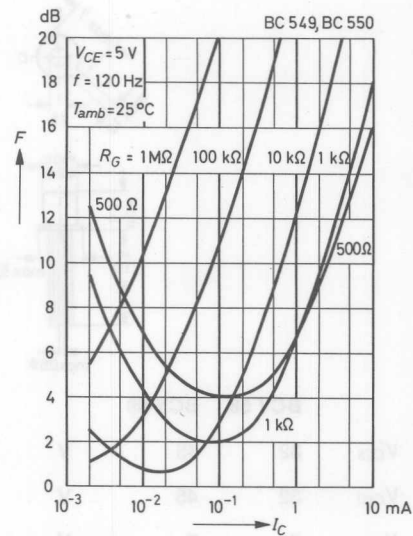
Gain bandwidth product
versus
collector current



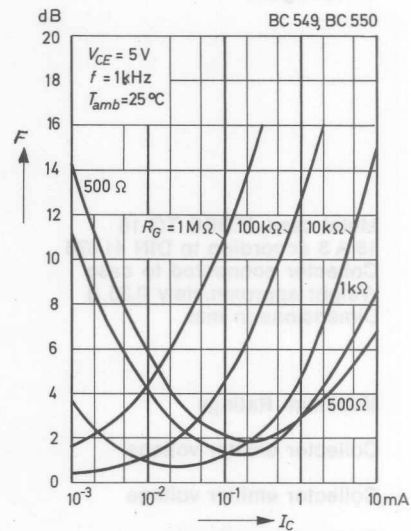
Relative h -parameters
versus
collector current



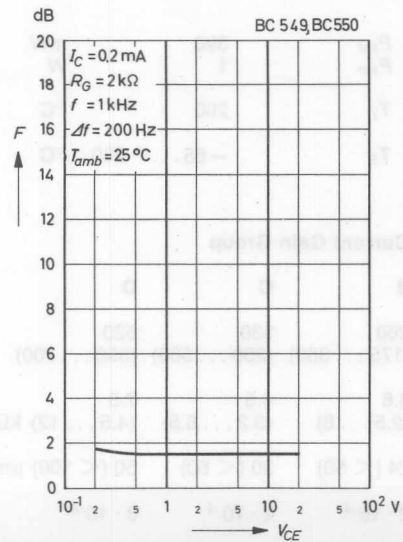
Noise figure
versus collector current



Noise figure
versus collector current



Noise figure
versus collector emitter voltage



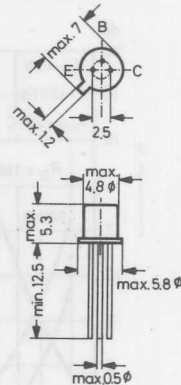
BCY 58, BCY 59

NPN Silicon Epitaxial Planar Transistors

for switching and amplifier applications
in commercial electronic design

The transistors are subdivided into four groups A, B, C and D according to their current gain.

Metal case JEDEC TO-18
18 A 3 according to DIN 41876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm



Maximum Ratings

		BCY 58	BCY 59	
Collector emitter voltage	V_{CES}	32	45	V
Collector emitter voltage	V_{CE0}	32	45	V
Emitter base voltage	V_{EB0}	7	7	V
Collector current	I_C	200		mA
Base current	I_B	50		mA
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}	390		mW
at $T_C = 45^\circ\text{C}$	P_{tot}	1		W
Junction temperature	T_j	200		$^\circ\text{C}$
Storage temperature range	T_S	-65 ... +200		$^\circ\text{C}$

Characteristics at $T_{amb} = 25^\circ\text{C}$

h -Parameter at $V_{CE} = 5\text{ V}$,
 $I_C = 2\text{ mA}$, $f = 1\text{ kHz}$

		A	B	C	D
Small signal current gain	h_{fe}	200 (125 ... 250)	260 (175 ... 350)	330 (250 ... 500)	520 (350 ... 700)
Input impedance	h_{ie}	2.7 (1.6 ... 4.5)	3.6 (2.5 ... 6)	4.5 (3.2 ... 8.5)	7.5 (4.5 ... 12) k Ω
Output admittance	h_{oe}	18 (< 30)	24 (< 50)	30 (< 60)	50 (< 100) μmho
Reverse voltage transfer ratio	h_{re}	$1.5 \cdot 10^{-4}$	$2 \cdot 10^{-4}$	$2 \cdot 10^{-4}$	$3 \cdot 10^{-4}$

Current Gain Group

BCY 58, BCY 59

Current Gain Group

	A	B	C	D
DC current gain				
at $V_{CE} = 5\text{ V}$, $I_C = 10\text{ }\mu\text{A}$	$h_{FE} 78$	145 (> 20)	220 (> 40)	300 (> 100)
at $V_{CE} = 5\text{ V}$, $I_C = 2\text{ mA}$	$h_{FE} 170$ (120 ... 220)	250 (180 ... 310)	350 (250 ... 460)	500 (380 ... 630)
at $V_{CE} = 1\text{ V}$, $I_C = 10\text{ mA}$	$h_{FE} 190$ (> 80)	260 (120 ... 400)	380 (160 ... 630)	550 (240 ... 1000)
at $V_{CE} = 1\text{ V}$, $I_C = 100\text{ mA}$	$h_{FE} > 40$	> 45	> 60	> 60

Base emitter voltage

at $V_{CE} = 5\text{ V}$, $I_C = 10\text{ }\mu\text{A}$	V_{BE}	0.5	V
at $V_{CE} = 5\text{ V}$, $I_C = 2\text{ mA}$	V_{BE}	0.62 (0.55 ... 0.7)	V
at $V_{CE} = 1\text{ V}$, $I_C = 10\text{ mA}$	V_{BE}	0.7	V
at $V_{CE} = 1\text{ V}$, $I_C = 100\text{ mA}$	V_{BE}	0.76	V

Collector saturation voltage

at $I_C = 10\text{ mA}$, $I_B = 0.25\text{ mA}$	$V_{CE\text{ sat}}$	0.12 (0.05 ... 0.35)	V
at $I_C = 100\text{ mA}$, $I_B = 2.5\text{ mA}$	$V_{CE\text{ sat}}$	0.3 (0.15 ... 0.7)	V

Base saturation voltage

at $I_C = 10\text{ mA}$, $I_B = 0.25\text{ mA}$	$V_{BE\text{ sat}}$	0.7 (0.6 ... 0.85)	V
at $I_C = 100\text{ mA}$, $I_B = 2.5\text{ mA}$	$V_{BE\text{ sat}}$	0.9 (0.75 ... 1.2)	V

Collector cutoff current

	BCY 58	BCY 59	
at $V_{CE} = 32\text{ V}$	$I_{CES} 0.2$ (< 10)	—	nA
at $V_{CE} = 45\text{ V}$	I_{CES} —	0.2 (< 10)	nA
at $V_{CE} = 32\text{ V}$, $T_{amb} = 150\text{ }^\circ\text{C}$	$I_{CES} 0.2$ (< 10)	—	μA
at $V_{CE} = 45\text{ V}$, $T_{amb} = 150\text{ }^\circ\text{C}$	I_{CES} —	0.2 (< 10)	μA
at $V_{CE} = 32\text{ V}$, $V_{BE} = 0.2\text{ V}$, $T_{amb} = 100\text{ }^\circ\text{C}$	$I_{CEV} < 20$	—	μA
at $V_{CE} = 45\text{ V}$, $V_{BE} = 0.2\text{ V}$, $T_{amb} = 100\text{ }^\circ\text{C}$	I_{CEV} —	< 20	μA

Emitter cutoff current

at $V_{EB} = 5\text{ V}$	I_{EBO}	< 10	< 10	nA
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Collector emitter breakdown voltage

at $I_C = 2\text{ mA}$	$V_{(BR)CEO}$	> 32	> 45	V
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Emitter base breakdown voltage

at $I_E = 1\text{ }\mu\text{A}$	$V_{(BR)EBO}$	> 7	> 7	V
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Gain bandwidth product

at $V_{CE} = 5\text{ V}$, $I_C = 10\text{ mA}$, $f = 100\text{ MHz}$	f_T	250 (> 125)		MHz
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Collector base capacitance

at $V_{CBO} = 10\text{ V}$, $f = 1\text{ MHz}$	C_{CBO}	3.5 (< 6)		pF
---	-----------	---------------	--	----

Emitter base capacitance

at $V_{EBO} = 0.5\text{ V}$, $f = 1\text{ MHz}$	C_{EBO}	8 (< 15)		pF
--	-----------	--------------	--	----

BCY 58, BCY 59

Noise figure
at $V_{CE} = 5\text{ V}$, $I_C = 0.2\text{ mA}$,
 $R_G = 2\text{ k}\Omega$, $f = 1\text{ kHz}$, $\Delta f = 200\text{ Hz}$

F 2 (< 6) dB

Thermal resistance
Junction to ambient air
Junction to case

$R_{th A}$ < 450 °C/W
 $R_{th C}$ < 150 °C/W

Switching Times

Test conditions:

$I_C : I_{B1} : -I_{B2} \sim 10 : 1 : 1\text{ mA}$, $R_1 = 5\text{ k}\Omega$, $R_2 = 5\text{ k}\Omega$, $R_L = 990\text{ }\Omega$, $-V_{BB} = 3.6\text{ V}$

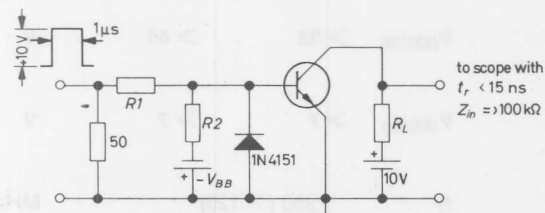
Delay time	t_d	35	ns
Rise time	t_r	50	ns
Turn-on time	t_{on}	85 (< 150)	ns
Storage time	t_s	400	ns
Fall time	t_f	80	ns
Turn-off time	t_{off}	480 (< 800)	ns

Test conditions:

$I_C : I_{B1} : -I_{B2} \sim 100 : 10 : 10\text{ mA}$, $R_1 = 500\text{ }\Omega$, $R_2 = 700\text{ }\Omega$, $R_L = 98\text{ }\Omega$, $-V_{BB} = 5\text{ V}$

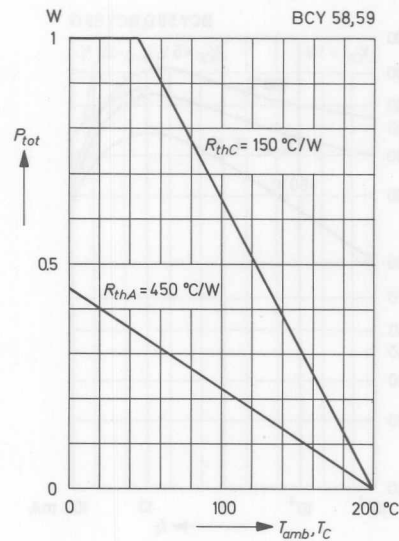
Delay time	t_d	5	ns
Rise time	t_r	50	ns
Turn-on time	t_{on}	55 (< 150)	ns
Storage time	t_s	250	ns
Fall time	t_f	200	ns
Turn-off time	t_{off}	450 (< 800)	ns

Test Circuit for Switching Times

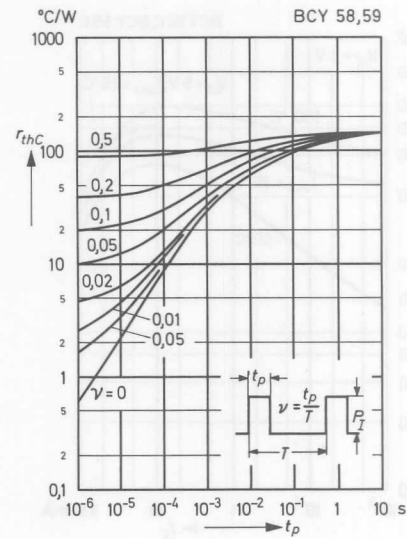


Rise time of input voltage 5 ns, pulse duty factor < 1 %, generator impedance 50 Ω

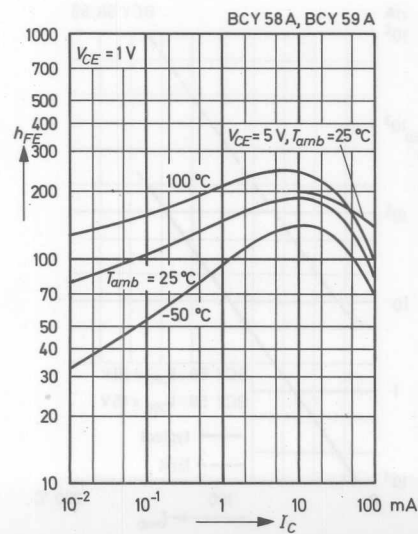
**Admissible power dissipation
versus temperature**



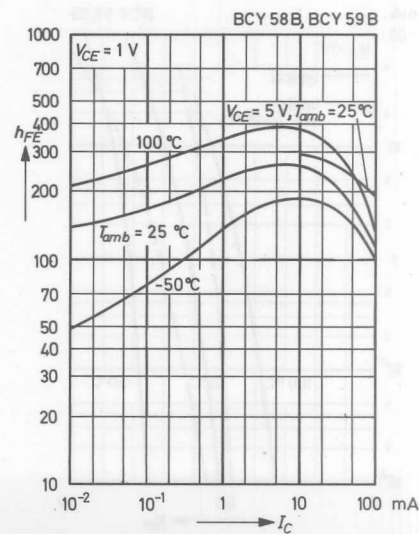
**Pulse thermal resistance
versus pulse duration**



**DC current gain
versus collector current**

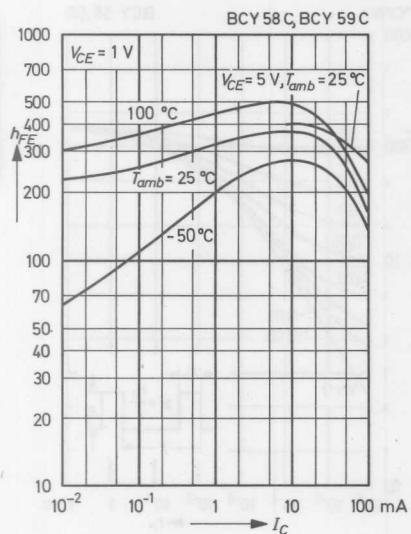


**DC current gain
versus collector current**

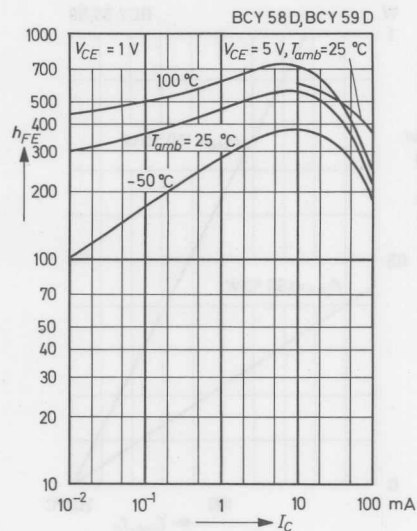


BCY 58, BCY 59

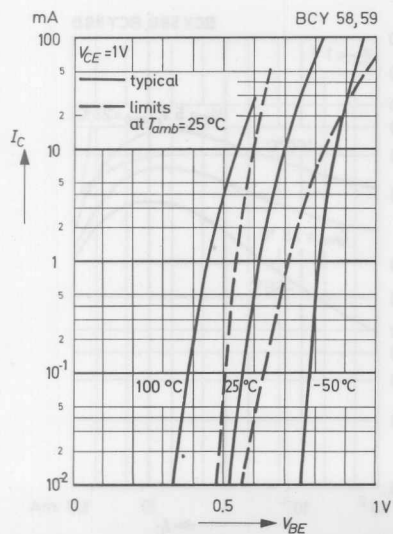
DC current gain
versus collector current



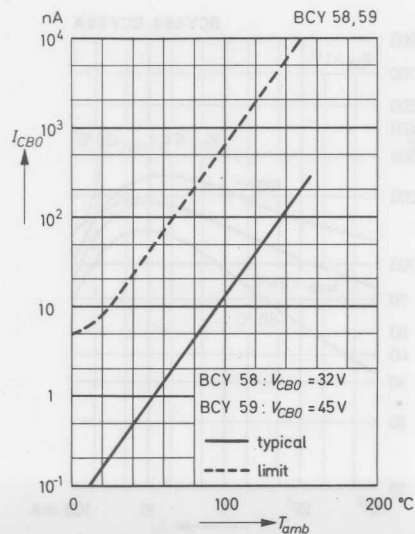
DC current gain
versus collector current



Collector current versus
base emitter voltage

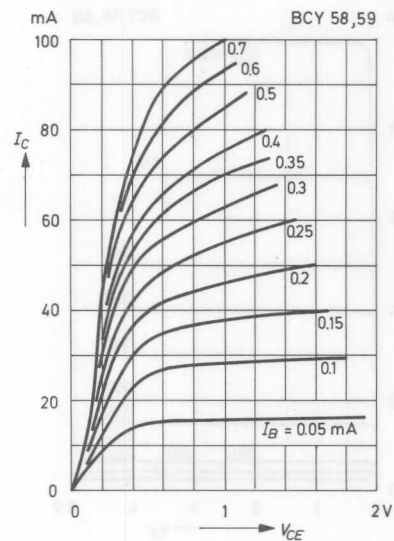


Collector cutoff current
versus ambient temperature

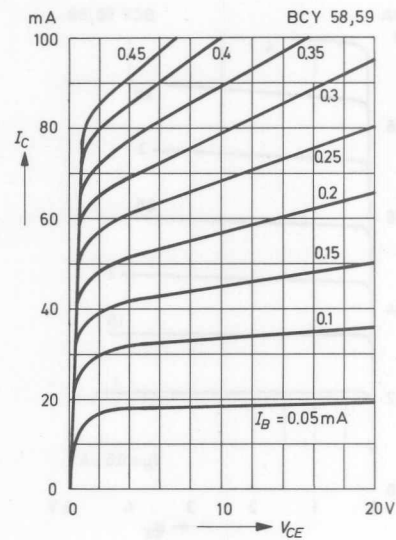


BCY 58, BCY 59

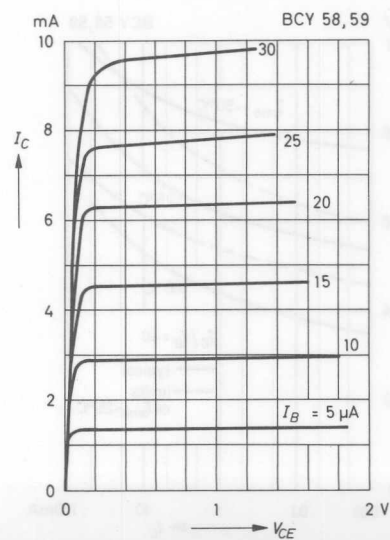
Common emitter
collector characteristics



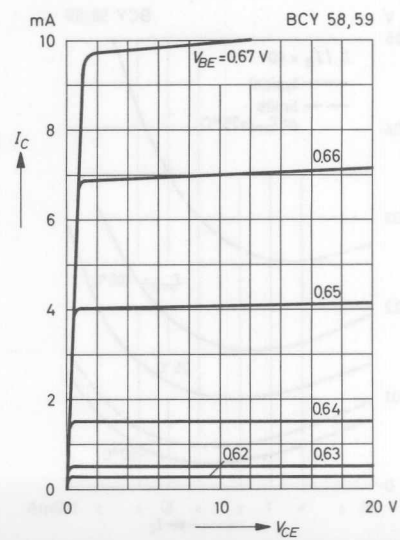
Common emitter
collector characteristics



Common emitter
collector characteristics

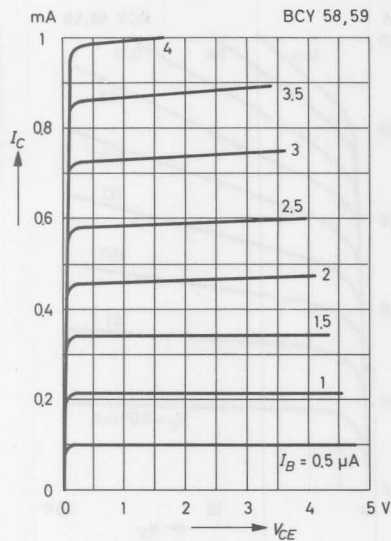


Common emitter
collector characteristics

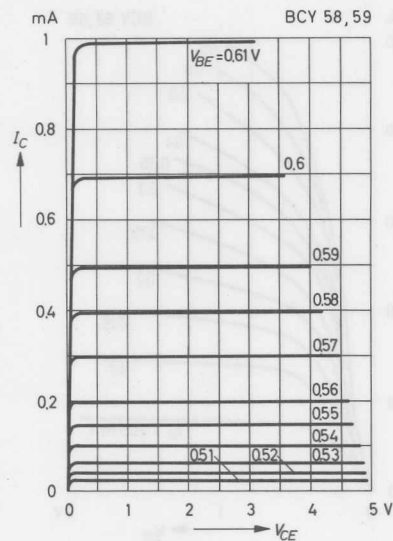


BCY 58, BCY 59

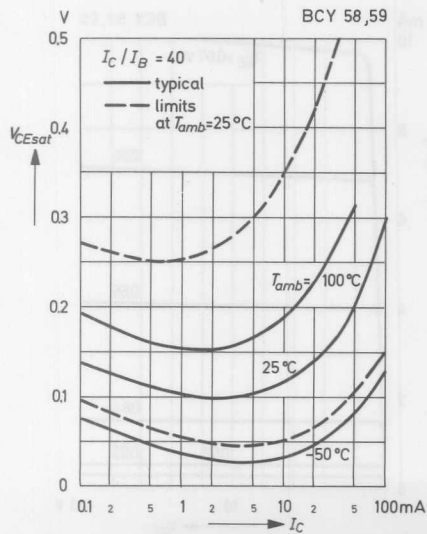
Common emitter
collector characteristics



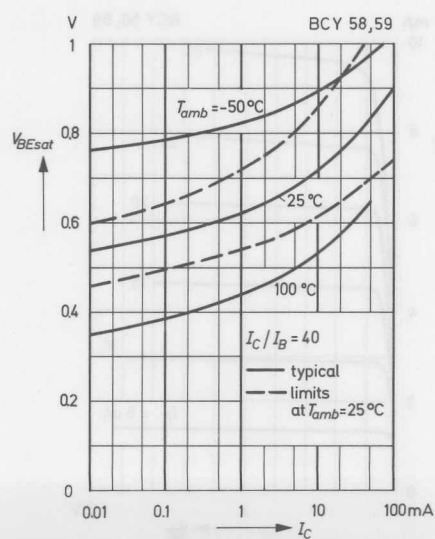
Common emitter
collector characteristics



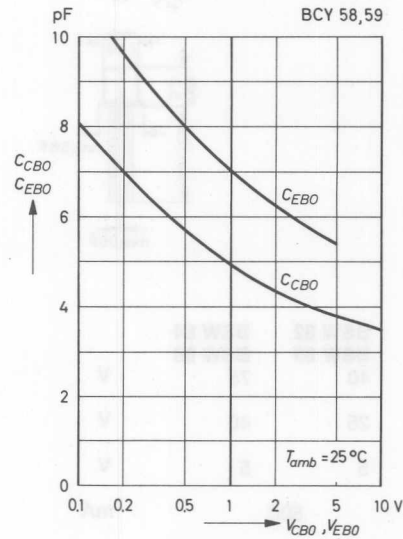
Collector saturation voltage
versus collector current



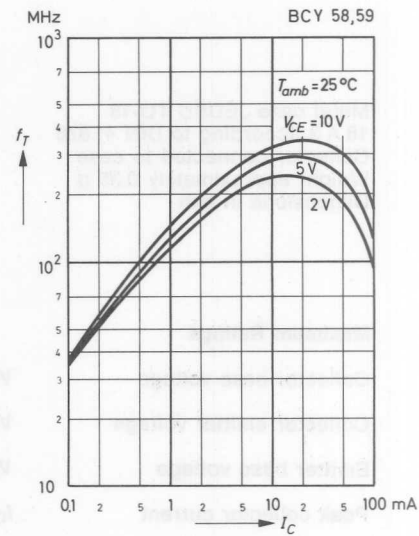
Base saturation voltage
versus collector current



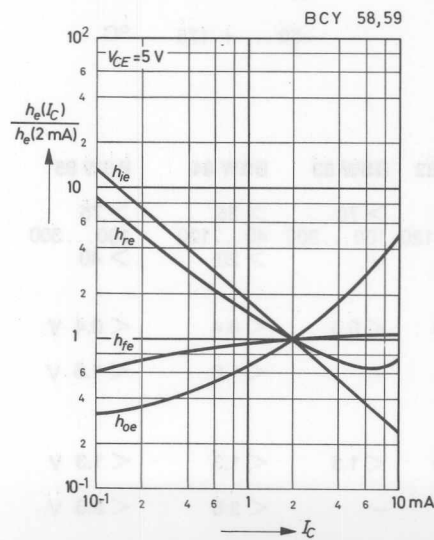
**Collector base capacitance,
Emitter base capacitance
versus reverse bias voltage**



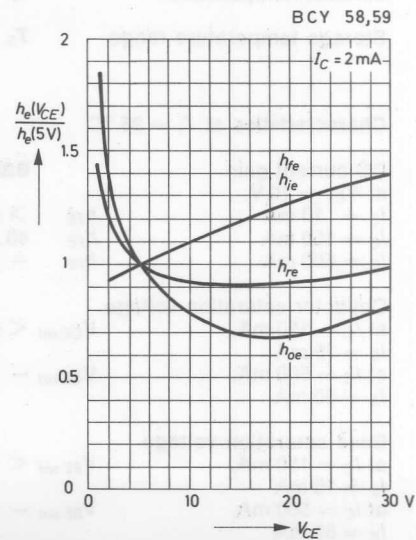
**Gain bandwidth product
versus
collector current**



**Relative h -parameters
versus
collector current**



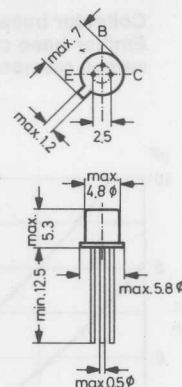
**Relative h -parameters
versus
collector emitter voltage**



BSW 82, BSW 83, BSW 84, BSW 85

NPN Silicon Epitaxial Planar Transistors
with high cutoff frequency, for high speed switching

Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm



Maximum Ratings

		BSW 82 BSW 83	BSW 84 BSW 85	
Collector base voltage	V_{CB0}	40	75	V
Collector emitter voltage	V_{CE0}	25	40	V
Emitter base voltage	V_{EB0}	5	5	V
Peak collector current	I_{CM}	500		mA
Power dissipation				
at $T_{amb} = 25^{\circ}\text{C}$	P_{tot}	500		mW
at $T_C = 25^{\circ}\text{C}$	P_{tot}	1.8		W
Junction temperature	T_j	175		$^{\circ}\text{C}$
Storage temperature range	T_s	-50 ... + 175		$^{\circ}\text{C}$

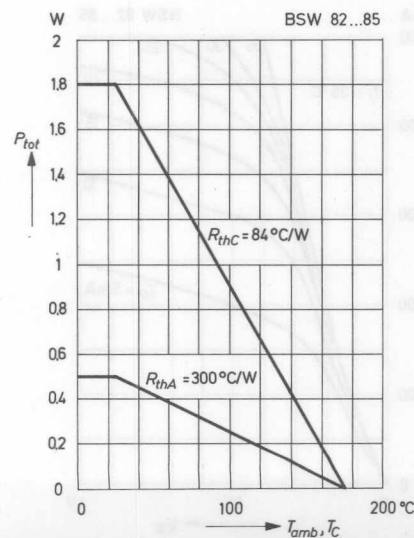
Characteristics at $T_j = 25^{\circ}\text{C}$

		BSW 82	BSW 83	BSW 84	BSW 85
DC current gain					
at $V_{CE} = 10\text{ V}$,					
$I_C = 10\text{ mA}$	h_{FE}	> 30	> 70	> 35	> 75
$I_C = 150\text{ mA}$	h_{FE}	40 ... 120	100 ... 300	40 ... 120	100 ... 300
$I_C = 500\text{ mA}$	h_{FE}	—	—	> 20	> 40
Collector saturation voltage					
at $I_C = 150\text{ mA}$,	$V_{CE sat}$	< 0.6	< 0.6	< 0.4	< 0.4 V
$I_B = 15\text{ mA}$					
at $I_C = 500\text{ mA}$,	$V_{CE sat}$	—	—	< 1.6	< 1.6 V
$I_B = 50\text{ mA}$					
Base saturation voltage					
at $I_C = 150\text{ mA}$,	$V_{BE sat}$	< 1.3	< 1.3	< 1.3	< 1.3 V
$I_B = 15\text{ mA}$					
at $I_C = 500\text{ mA}$,	$V_{BE sat}$	—	—	< 2.6	< 2.6 V
$I_B = 50\text{ mA}$					

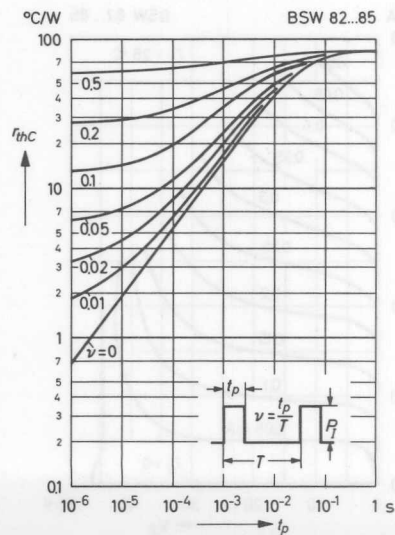
BSW 82, BSW 83, BSW 84, BSW 85

	BSW 82	BSW 83	BSW 84	BSW 85
Collector cutoff current at $V_{CB} = 30\text{ V}$	$I_{CB0} < 100$	< 100	—	— nA
at $V_{CB} = 50\text{ V}$	$I_{CB0} —$	—	< 10	< 10 nA
at $V_{CB} = 30\text{ V}, T_i = 125\text{ °C}$	$I_{CB0} < 100$	< 100	—	— μA
at $V_{CB} = 50\text{ V}, T_i = 125\text{ °C}$	$I_{CB0} —$	—	< 10	< 10 μA
Emitter cutoff current at $V_{EB} = 3\text{ V}$	I_{EB0}	< 100		nA
Gain bandwidth product at $V_{CE} = 20\text{ V}, I_C = 20\text{ mA},$ $f = 100\text{ MHz}$	f_T	> 200		MHz
Collector base capacitance at $V_{CB0} = 10\text{ V}, f = 100\text{ kHz}$	C_{CB0}	< 8		pF
Thermal resistance Junction to ambient air	R_{thA}	< 300		°C/W
Junction to case	R_{thC}	< 84		°C/W

Admissible power dissipation
versus temperature

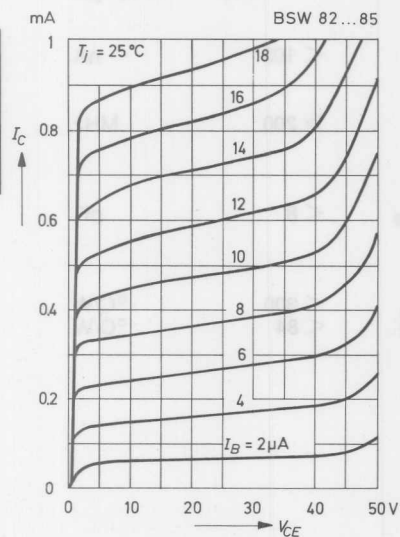


Pulse thermal resistance
versus pulse duration

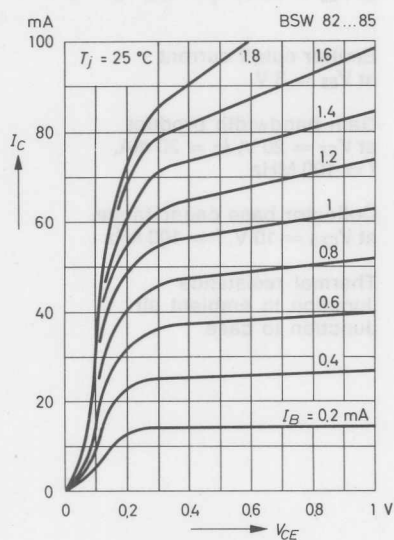


BSW 82, BSW 83, BSW 84, BSW 85

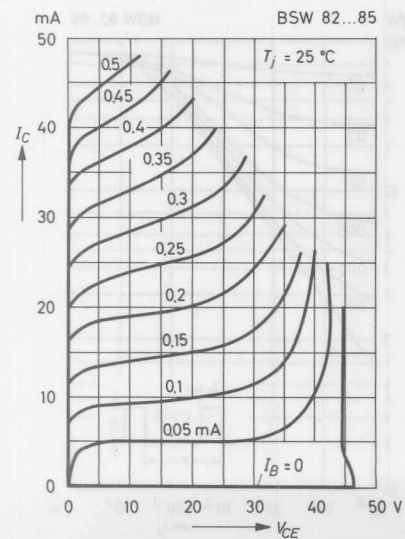
Common emitter
collector characteristics



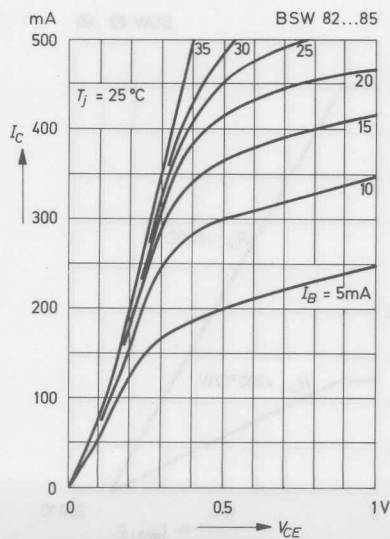
Common emitter
collector characteristics



Common emitter
collector characteristics

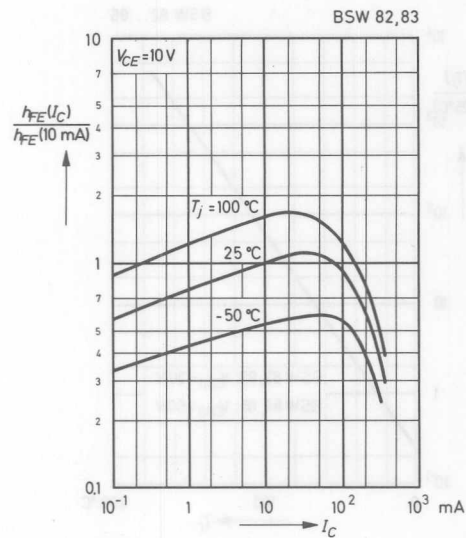


Common emitter
collector characteristics

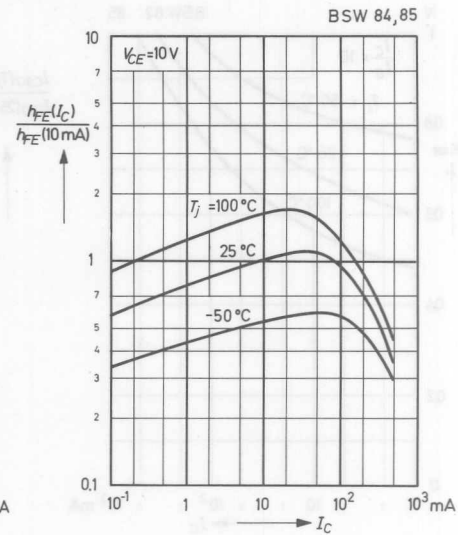


BSW 82, BSW 83, BSW 84, BSW 85

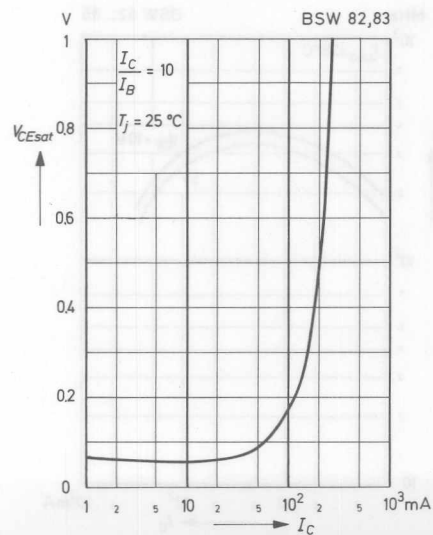
Relative DC current gain
versus collector current



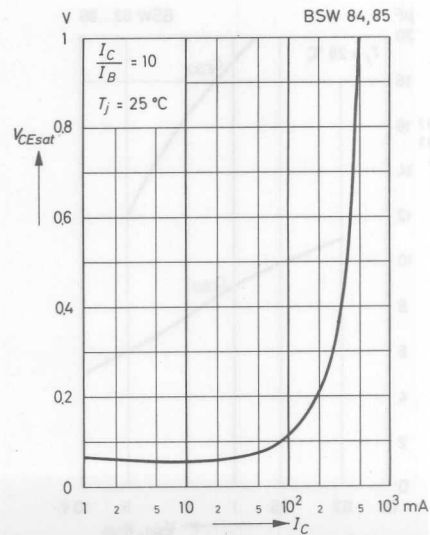
Relative DC current gain
versus collector current



Collector saturation voltage
versus collector current

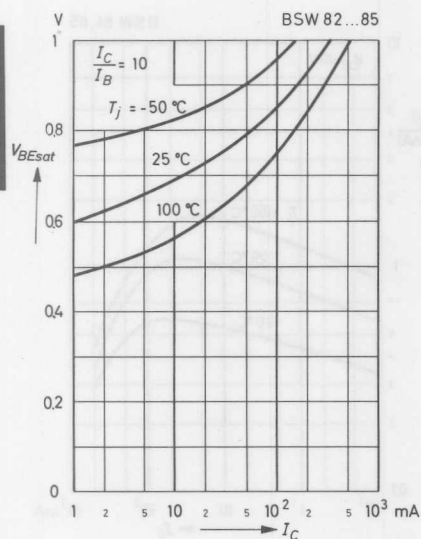


Collector saturation voltage
versus collector current

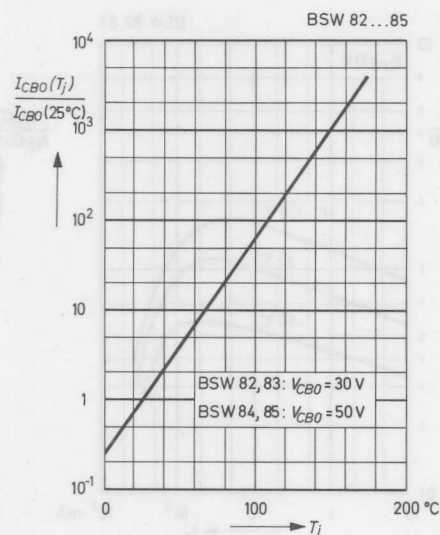


BSW 82, BSW 83, BSW 84, BSW 85

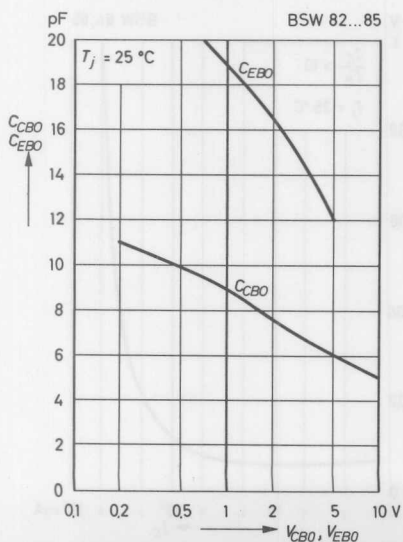
Base saturation voltage
versus collector current



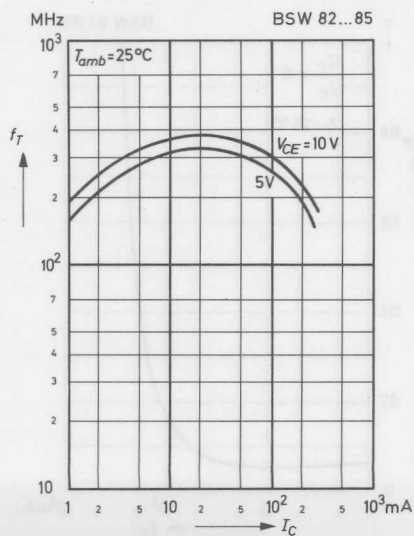
Collector cutoff current
versus junction temperature



Collector base capacitance,
Emitter base capacitance
versus reverse bias voltage



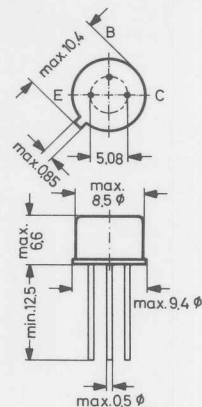
Gain bandwidth product
versus
collector current



BSW 82, BSW 83, BSW 84, BSW 85

NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	60	V
Collector emitter voltage	V_{CE0}	25	V
Emitter base voltage	V_{EB0}	5	V
Collector current	I_C	500	mA
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 100^\circ\text{C}$	P_{tot}	1.7	W
at $T_C = 25^\circ\text{C}$	P_{tot}	3	W
Junction temperature	T_i	200	$^\circ\text{C}$

Static Characteristics at $T_i = 25^\circ\text{C}$

DC current gain			
at $V_{CE} = 10\text{ V}, I_C = 1\text{ mA}$	h_{FE}	50	
at $V_{CE} = 10\text{ V}, I_C = 10\text{ mA}$	h_{FE}	75 (> 30)	
at $V_{CE} = 10\text{ V}, I_C = 150\text{ mA}$	h_{FE}	40 ... 120	
at $V_{CE} = 10\text{ V}, I_C = 500\text{ mA}$	h_{FE}	15	
Collector saturation voltage	$V_{CE sat}$	0.15 (< 0.8)	V
at $I_C = 150\text{ mA}, I_B = 15\text{ mA}$			
Base saturation voltage	$V_{BE sat}$	0.95 (< 1.2)	V
at $I_C = 150\text{ mA}, I_B = 15\text{ mA}$			
Collector cutoff current			
at $V_{CB} = 30\text{ V}$	I_{CB0}	3 (< 100)	nA
at $V_{CB} = 30\text{ V}, T_{amb} = 150^\circ\text{C}$	I_{CB0}	4 (< 100)	μA
Emitter cutoff current	I_{EB0}	1 (< 50)	nA
at $V_{EB} = 3\text{ V}$			
Collector base capacitance	C_{CB0}	7.5 (< 10)	pF
at $V_{CB0} = 10\text{ V}$			
Emitter base capacitance	C_{EB0}	23 (< 33)	pF
at $V_{EB0} = 0.5\text{ V}$			

Thermal resistance
 Junction to ambient air
 Junction to case

$R_{th A}$ < 220 °C/W
 $R_{th C}$ < 58 °C/W

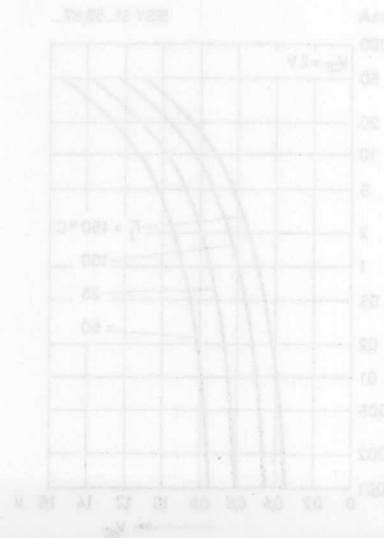
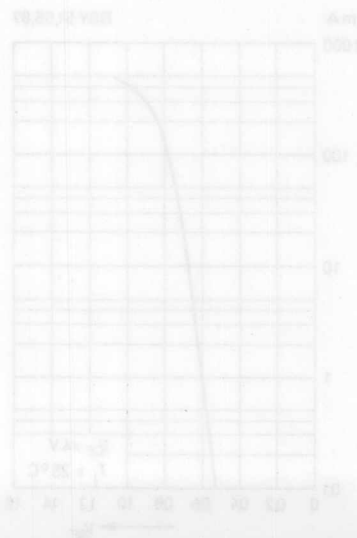
Small Signal Characteristics at $T_{amb} = 25$ °C and $f = 1$ kHz

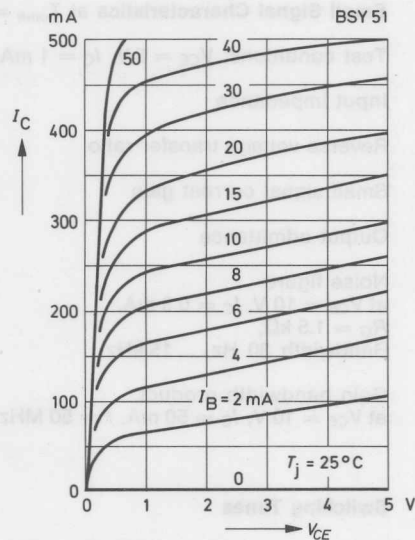
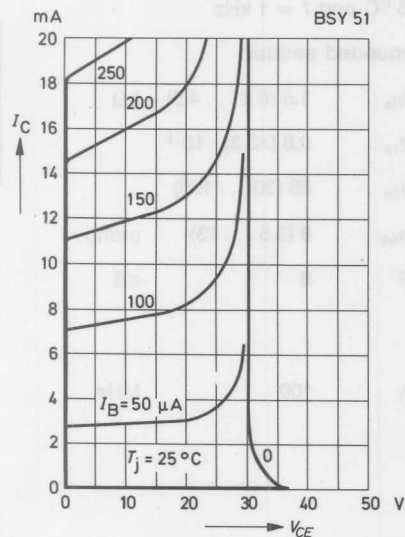
Test conditions: $V_{CE} = 5$ V, $I_C = 1$ mA, grounded emitter

Input impedance	h_{ie}	1.5 (0.8 ... 4.5)	k Ω
Reverse voltage transfer ratio	h_{re}	0.8 (< 3) $\cdot 10^{-4}$	
Small signal current gain	h_{fe}	55 (30 ... 100)	
Output admittance	h_{oe}	8 (3.5 ... 13)	μ mho
Noise figure at $V_{CE} = 10$ V, $I_C = 0.3$ mA, $R_G = 1.5$ k Ω , Bandwidth 30 Hz ... 15 kHz	F	6	dB
Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz	f_T	100	MHz

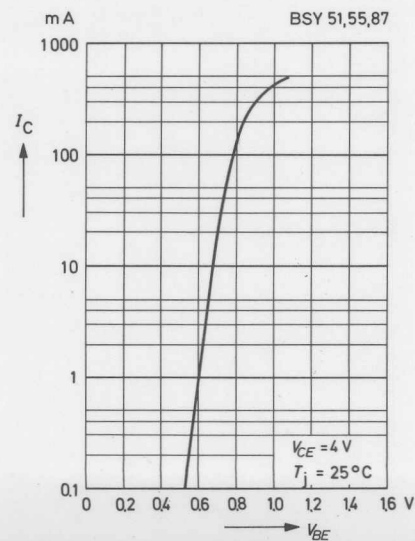
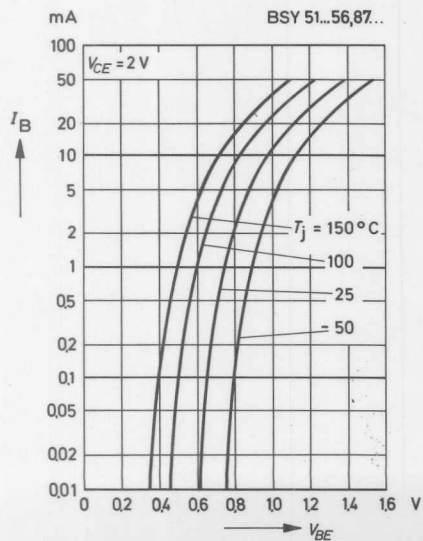
Switching Times

See diagrams and test circuits on the following pages.

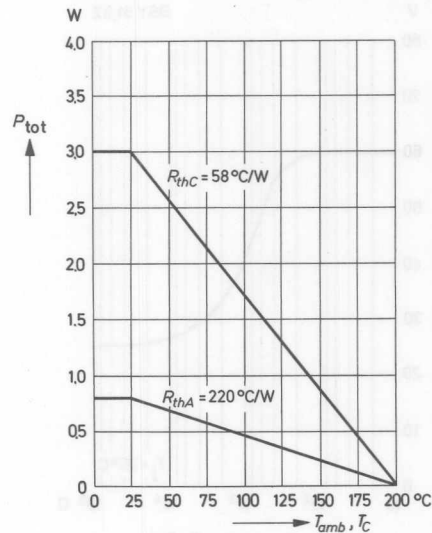




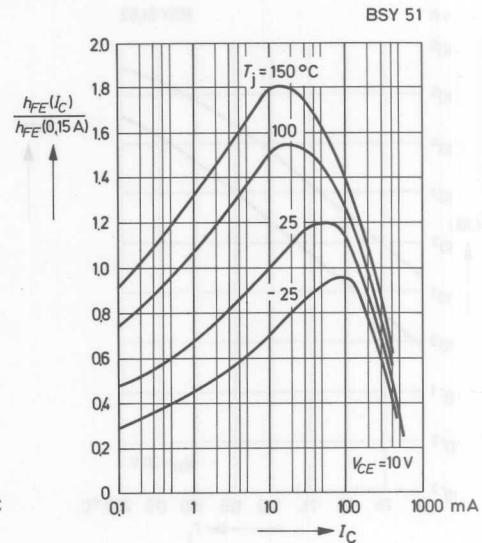
Common emitter
input characteristics



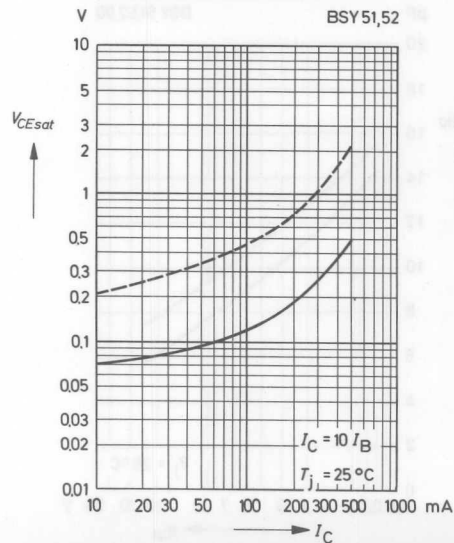
**Admissible power dissipation
versus temperature**



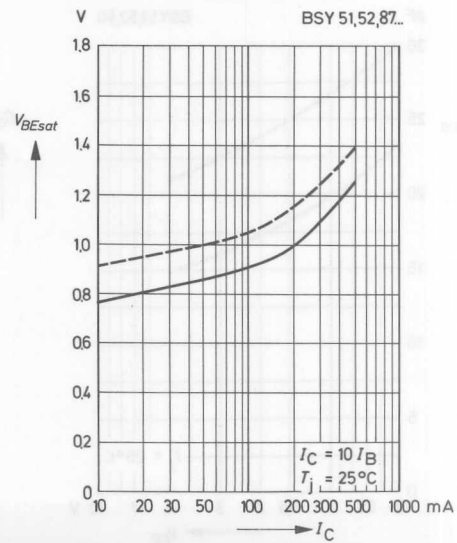
**Relative DC current gain
versus collector current**



**Collector saturation voltage
versus collector current**



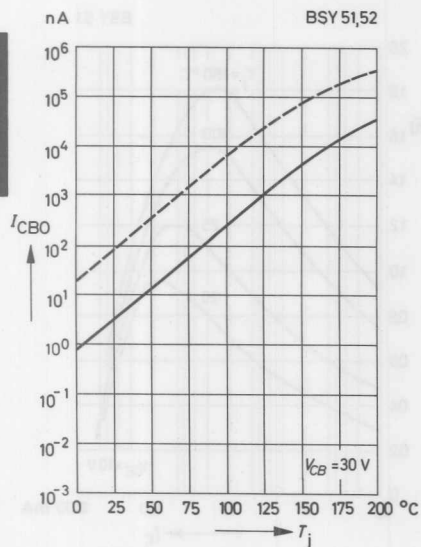
**Base saturation voltage
versus collector current**



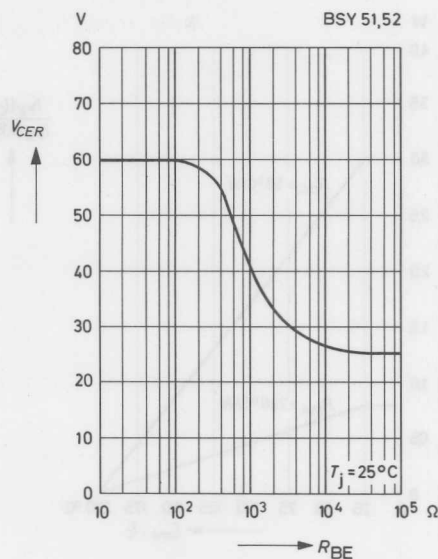
--- upper limit, valid for 95 % of a lot

BSY 51

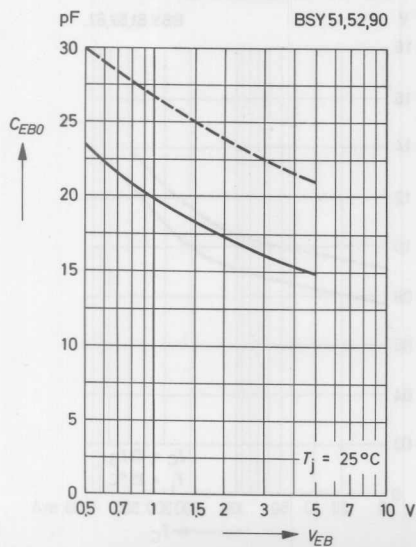
**Collector cutoff current
versus
junction temperature**



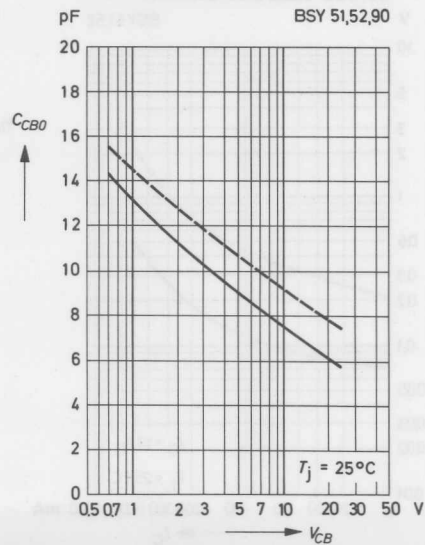
**Admissible collector emitter
voltage versus
base emitter resistance**



**Emitter base capacitance
versus
emitter base voltage**

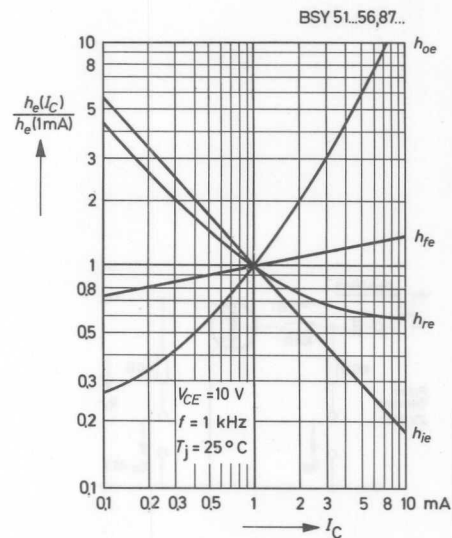


**Collector base capacitance
versus
collector base voltage**

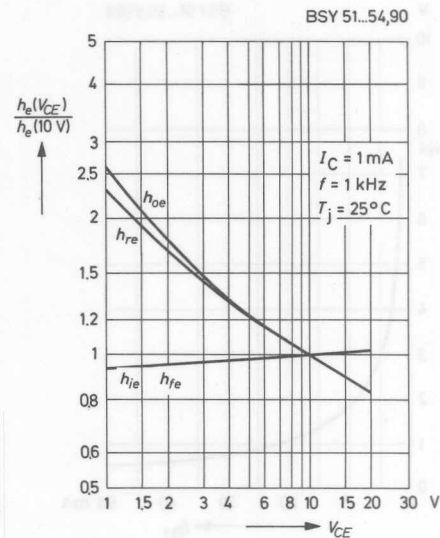


--- upper limit, valid for 95 % of a lot

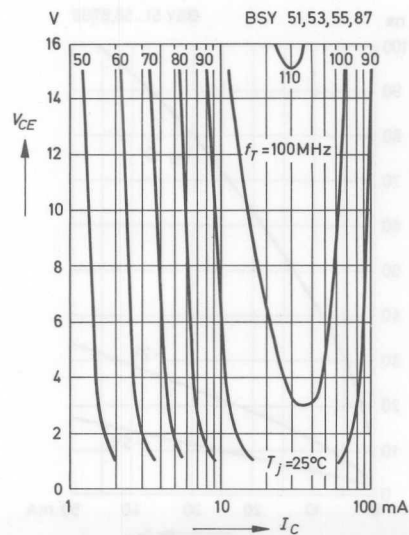
Relative h -parameters
versus
collector current



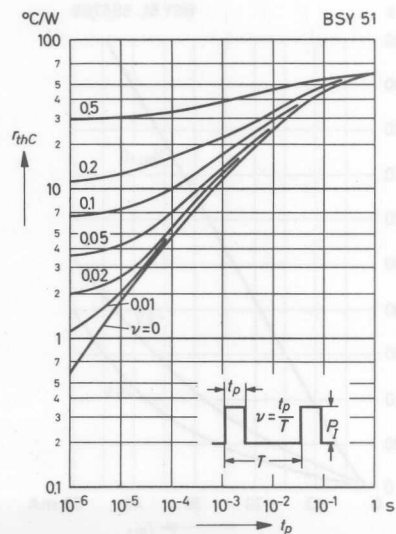
Relative h -parameters
versus
collector emitter voltage



Contours of constant
gain bandwidth product



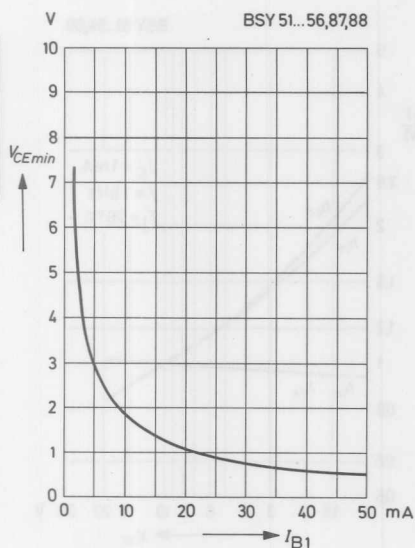
Pulse thermal resistance
versus pulse duration



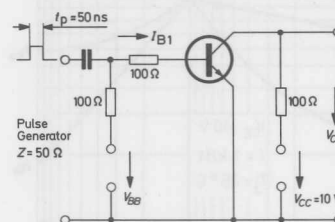
BSY 51

Switching characteristics, $I_C = 100 \text{ mA}^1$, $t_p = 50 \text{ ns}$

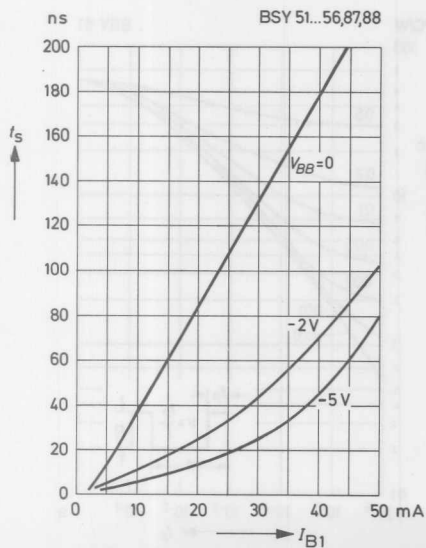
Residual collector emitter voltage versus base current



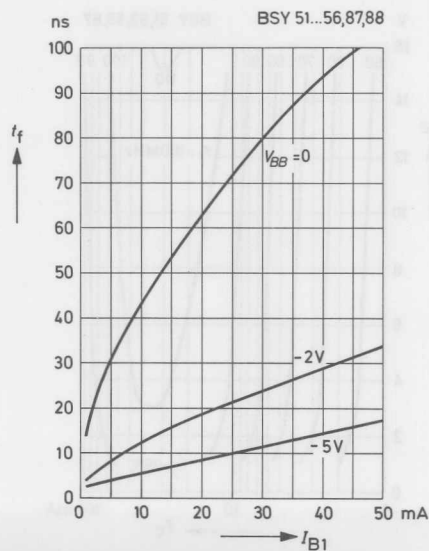
Test circuit



Storage time versus base current



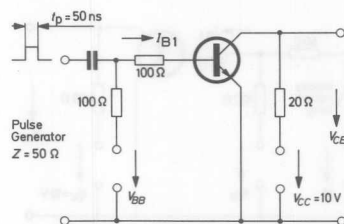
Fall time versus base current



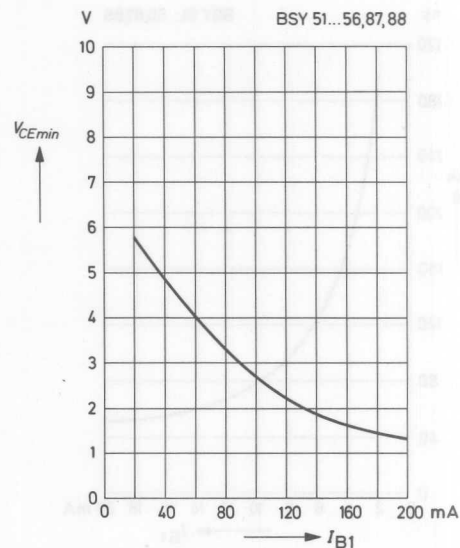
¹ 100 mA is that theoretical collector current which results from the supply voltage $V_{CC} = 10 \text{ V}$ and the operating resistor $R_{CC} = 100 \Omega$.

Switching characteristics, $I_C = 500 \text{ mA}^1$, $t_p = 50 \text{ ns}$

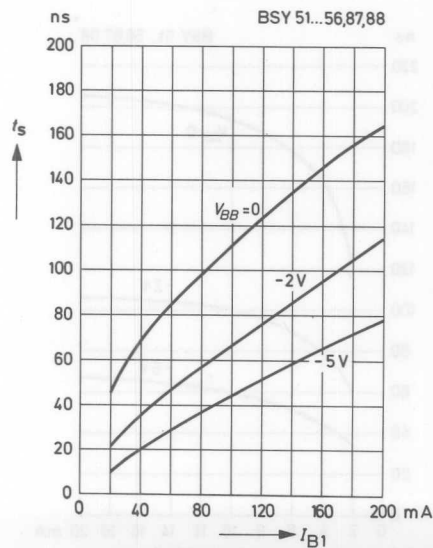
Test circuit



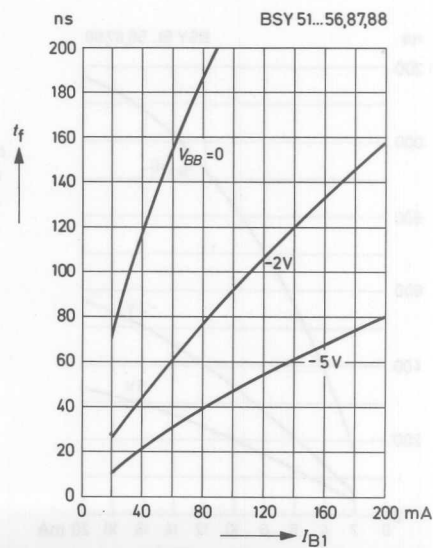
Residual collector emitter voltage versus base current



Storage time versus base current



Fall time versus base current

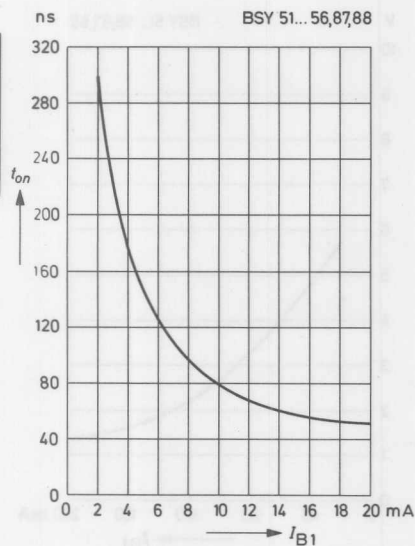


¹ 500 mA is that theoretical collector current which results from the supply voltage $V_{CC} = 10 \text{ V}$ and the operating resistor $R_{CC} = 20 \Omega$.

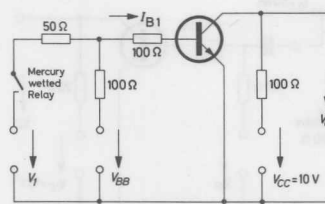
BSY 51

Switching characteristics, $I_C = 100 \text{ mA}$, $t_p > 10 \mu\text{s}$

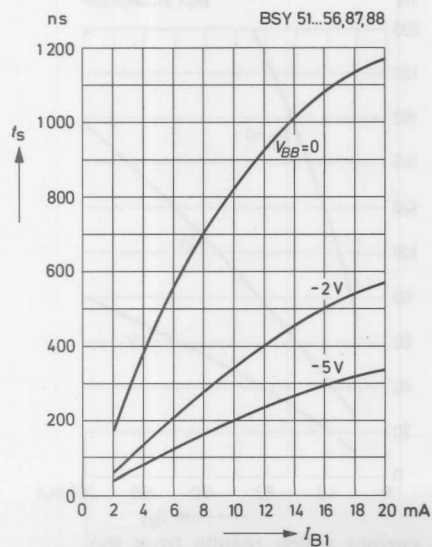
Turn-on time
versus base current



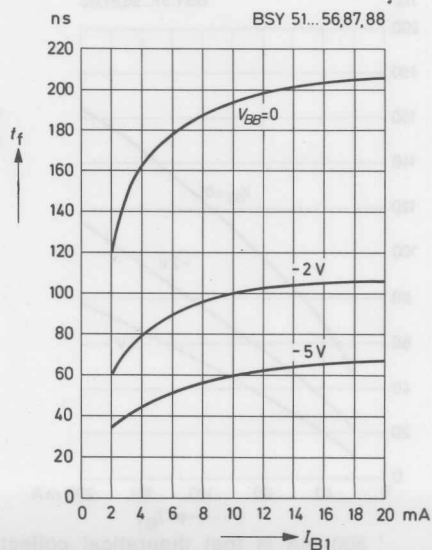
Test circuit



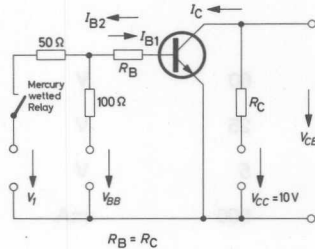
Storage time
versus base current



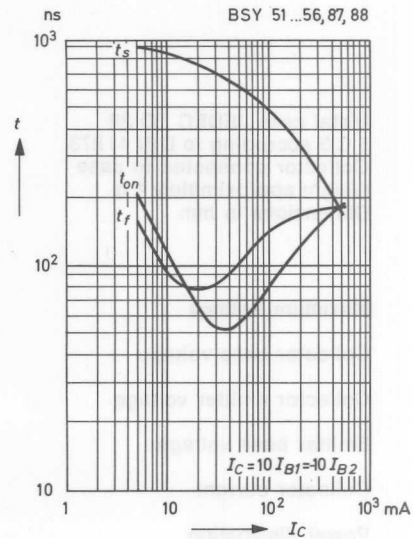
Fall time
versus base current



Test circuit
for graph on the right

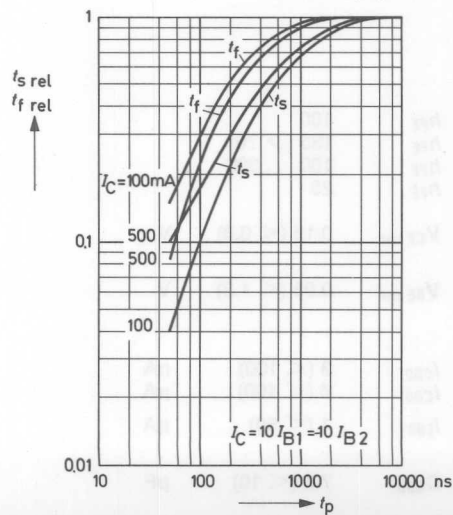


Switching characteristics
versus collector current
($t_p > 10 \mu s$)



Relative storage time and
fall time
versus pulse duration

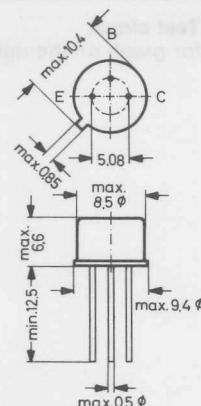
BSY 51...56,87,88



BSY 52 \approx 2N 1420

NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications

Metal case JEDEC TO-39
5 C 3 according to DIN 41873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	60	V
Collector emitter voltage	V_{CE0}	25	V
Emitter base voltage	V_{EB0}	5	V
Collector current	I_C	500	mA
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 100^\circ\text{C}$	P_{tot}	1.7	W
at $T_C = 25^\circ\text{C}$	P_{tot}	3	W
Junction temperature	T_j	200	$^\circ\text{C}$

Static Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$	h_{FE}	100
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$	h_{FE}	135 (> 70)
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$	h_{FE}	100 ... 300
at $V_{CE} = 10\text{ V}$, $I_C = 500\text{ mA}$	h_{FE}	25

Collector saturation voltage
at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$

$V_{CE\text{ sat}}$	0.15 (< 0.8)	V
---------------------	------------------	---

Base saturation voltage
at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$

$V_{BE\text{ sat}}$	0.95 (< 1.2)	V
---------------------	------------------	---

Collector cutoff current

at $V_{CB} = 30\text{ V}$
at $V_{CB} = 30\text{ V}$, $T_{amb} = 150^\circ\text{C}$

I_{CB0}	3 (< 100)	nA
I_{CB0}	4 (< 100)	μA

Emitter cutoff current
at $V_{EB} = 3\text{ V}$

I_{EB0}	1 (< 50)	nA
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Collector base capacitance
at $V_{CB0} = 5\text{ V}$

C_{CB0}	7.5 (< 10)	pF
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Emitter base capacitance at $V_{EB0} = 0.5 \text{ V}$	C_{EB0}	23 (< 33)	pF
Thermal resistance Junction to ambient air	$R_{th A}$	< 220	$^{\circ}\text{C/W}$
Junction to case	$R_{th C}$	< 58	$^{\circ}\text{C/W}$

Small Signal Characteristics at $T_{amb} = 25^{\circ}\text{C}$ and $f = 1 \text{ kHz}$

Test conditions: $V_{CE} = 5 \text{ V}$, $I_C = 1 \text{ mA}$, grounded emitter

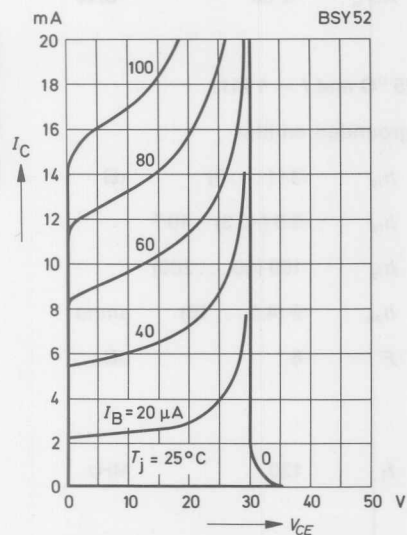
Input impedance	h_{ie}	3 (1 ... 8)	k Ω
Reverse voltage transfer ratio	h_{re}	$0.8 (< 3) \cdot 10^{-4}$	
Small signal current gain	h_{fe}	100 (50 ... 200)	
Output admittance	h_{oe}	9 (4.5 ... 15)	μmho
Noise figure at $V_{CE} = 10 \text{ V}$, $I_C = 0.3 \text{ mA}$, $R_G = 1.5 \text{ k}\Omega$ Bandwidth 30 Hz ... 15 kHz	F	6	dB
Gain bandwidth product at $V_{CE} = 10 \text{ V}$, $I_C = 50 \text{ mA}$, $f = 50 \text{ MHz}$	f_T	130	MHz

Switching Times

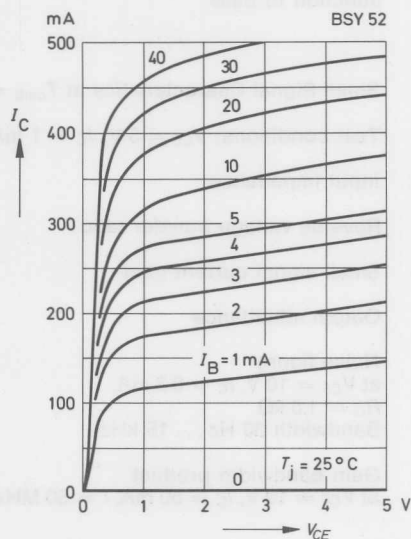
Specifications for switching times of type BSY 51 apply to this type.

BSY 52

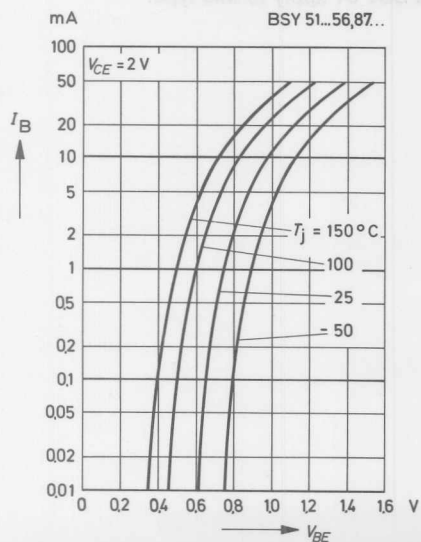
Common emitter
collector characteristics



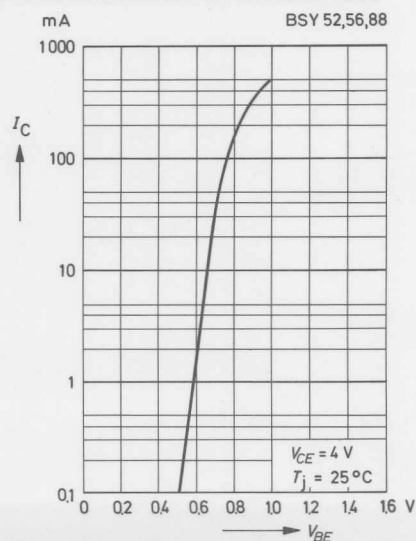
Common emitter
collector characteristics



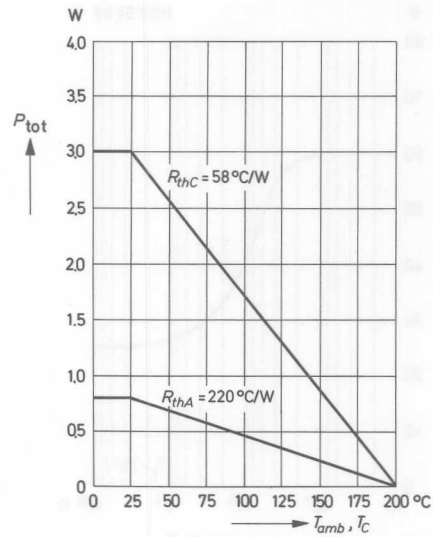
Common emitter
input characteristics



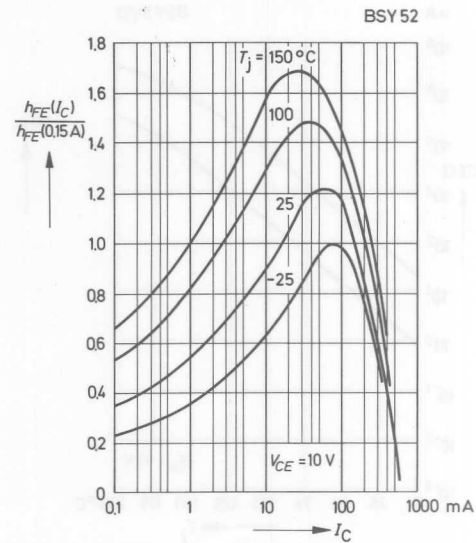
Collector current
versus base emitter voltage



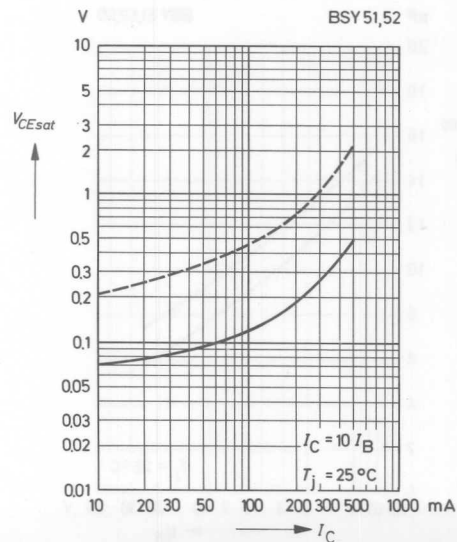
**Admissible power dissipation
versus temperature**



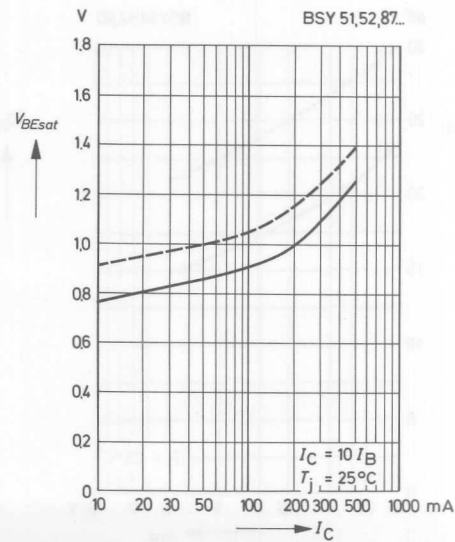
**Relative DC current gain
versus collector current**



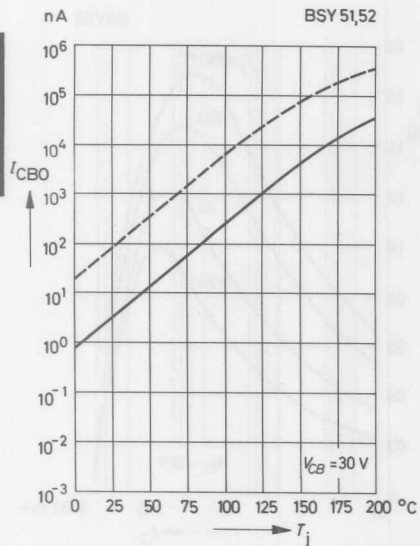
**Collector saturation voltage
versus collector current**



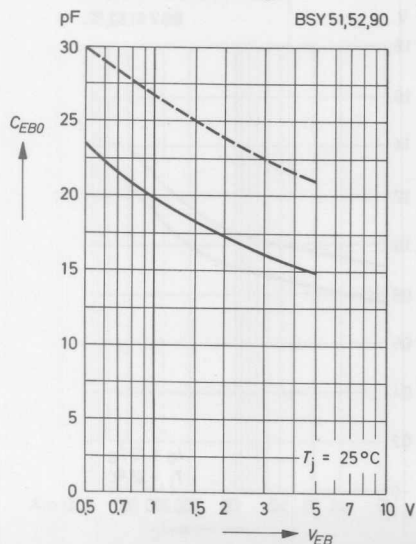
**Base saturation voltage
versus collector current**



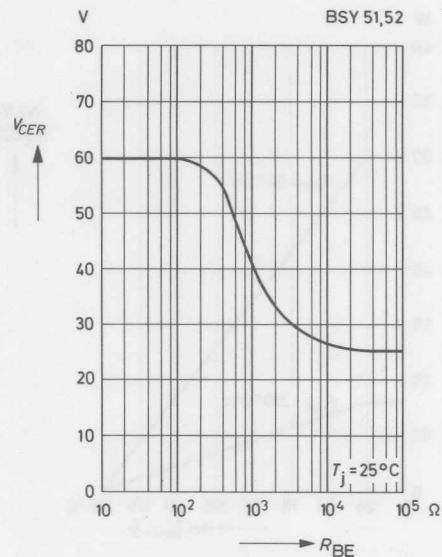
--- upper limit, valid for 95 % of a lot



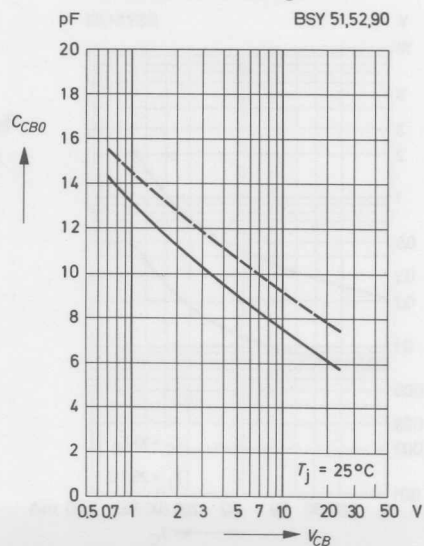
**Emitter base capacitance
versus
emitter base voltage**



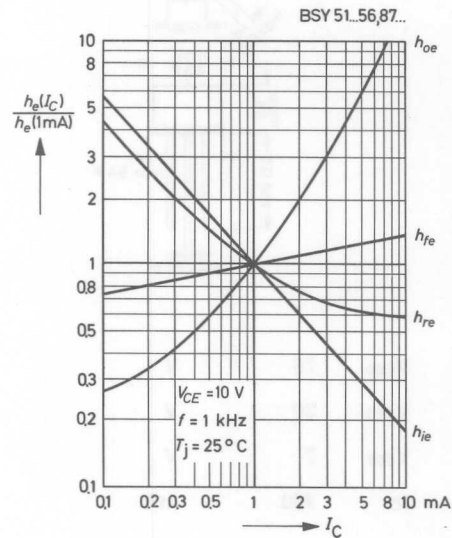
----- upper limit, valid for 95 % of a lot



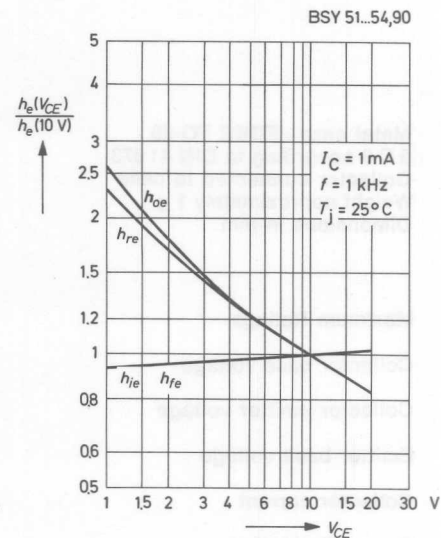
**Collector base capacitance
versus
collector base voltage**



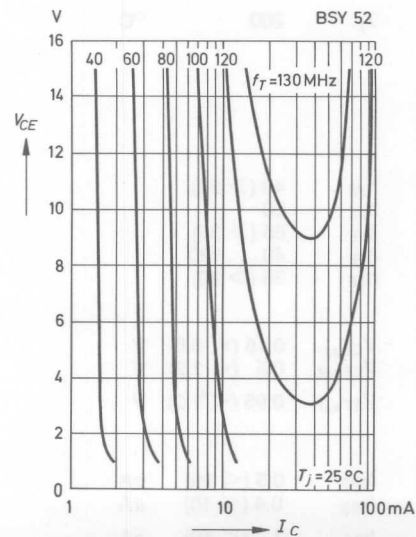
Relative h -parameters
versus collector current



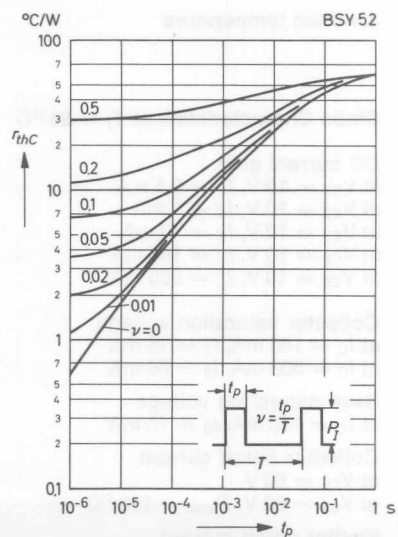
Relative h -parameters
versus collector emitter voltage



Contours of constant
gain bandwidth product



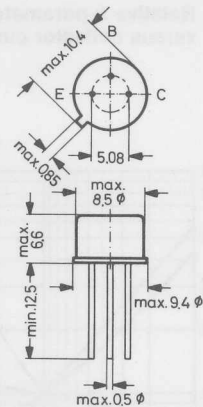
Pulse thermal resistance
versus pulse duration



BSY 53 \approx 2 N 1613

NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	75	V
Collector emitter voltage	V_{CE0}	30	V
Emitter base voltage	V_{EB0}	7	V
Collector current	I_C	750	mA
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 100^\circ\text{C}$	P_{tot}	1.7	W
at $T_C = 25^\circ\text{C}$	P_{tot}	3	W
Junction temperature	T_j	200	$^\circ\text{C}$

Static Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$	h_{FE}	40 (> 20)
at $V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$	h_{FE}	50
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$	h_{FE}	65 (> 35)
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$	h_{FE}	40 ... 120
at $V_{CE} = 10\text{ V}$, $I_C = 500\text{ mA}$	h_{FE}	35 (> 20)

Collector saturation voltage

at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$	$V_{CE\text{ sat}}$	0.15 (< 0.6)	V
at $I_C = 500\text{ mA}$, $I_B = 50\text{ mA}$	$V_{CE\text{ sat}}$	0.5 (< 1.2)	V

Base saturation voltage

at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$	$V_{BE\text{ sat}}$	0.95 (< 1.2)	V
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Collector cutoff current

at $V_{CB} = 60\text{ V}$	I_{CB0}	0.5 (< 10)	nA
at $V_{CB} = 60\text{ V}$, $T_{amb} = 150^\circ\text{C}$	I_{CB0}	0.4 (< 10)	μA

Emitter cutoff current

at $V_{EB} = 5\text{ V}$	I_{EB0}	1 (< 10)	nA
--------------------------	-----------	--------------	----

Collector base capacitance at $V_{CB0} = 10\text{ V}$	C_{CB0}	6.5 (< 10)	pF
Emitter base capacitance at $V_{EB0} = 0.5\text{ V}$	C_{EB0}	23 (< 33)	pF
Thermal resistance Junction to ambient air	$R_{th A}$	< 220	°C/W
Junction to case	$R_{th C}$	< 58	°C/W

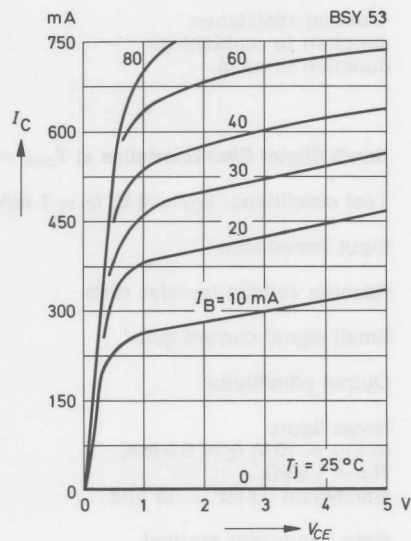
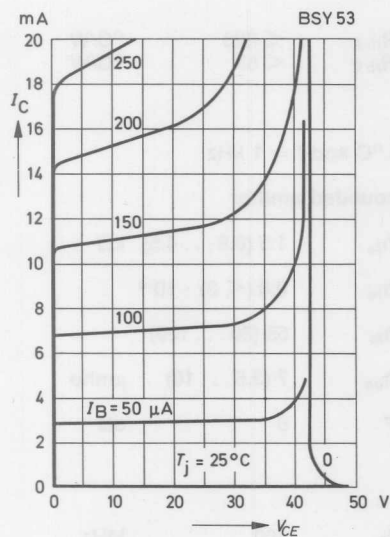
Small Signal Characteristics at $T_{amb} = 25\text{ °C}$ and $f = 1\text{ kHz}$

Test conditions: $V_{CE} = 5\text{ V}$, $I_C = 1\text{ mA}$, grounded emitter

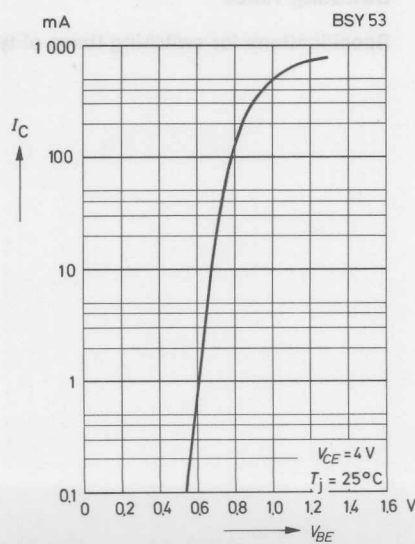
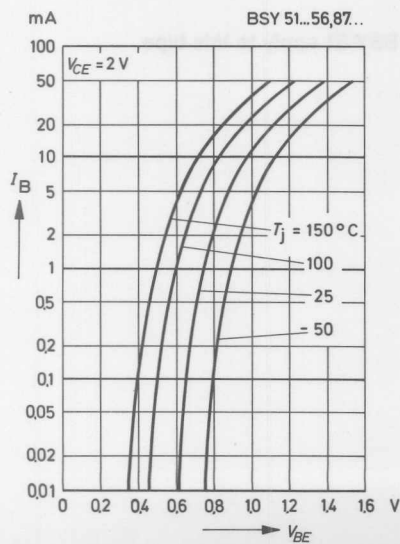
Input impedance	h_{ie}	1.5 (0.8 ... 4.5)	k Ω
Reverse voltage transfer ratio	h_{re}	0.8 (< 3) · 10 ⁻⁴	
Small signal current gain	h_{fe}	55 (30 ... 100)	
Output admittance	h_{oe}	7 (3.5 ... 10)	μmho
Noise figure at $V_{CE} = 10\text{ V}$, $I_C = 0.3\text{ mA}$, $R_G = 1.5\text{ k}\Omega$, Bandwidth 30 Hz ... 15 kHz	F	6	dB
Gain bandwidth product at $V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$, $f = 50\text{ MHz}$	f_T	100	MHz

Switching Times

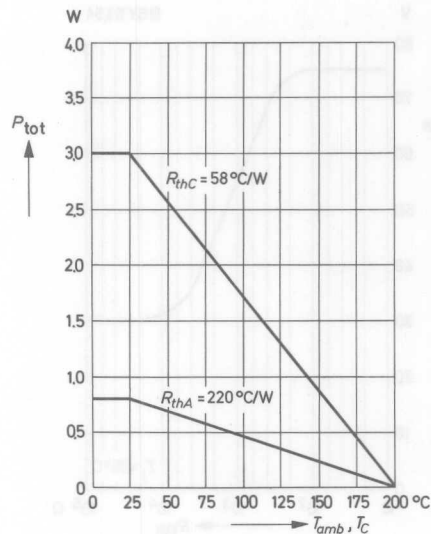
Specifications for switching times of type BSY 51 apply to this type.



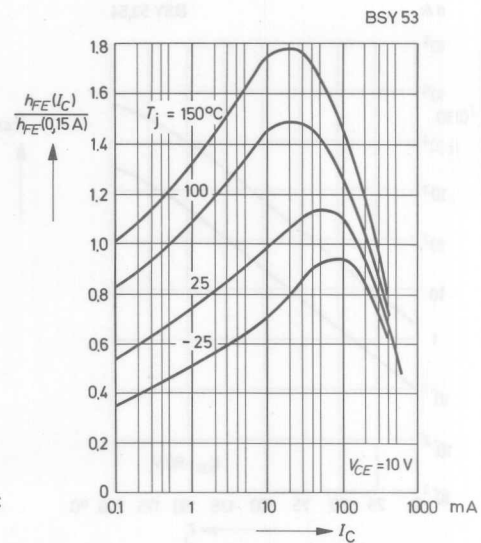
Common emitter
input characteristics



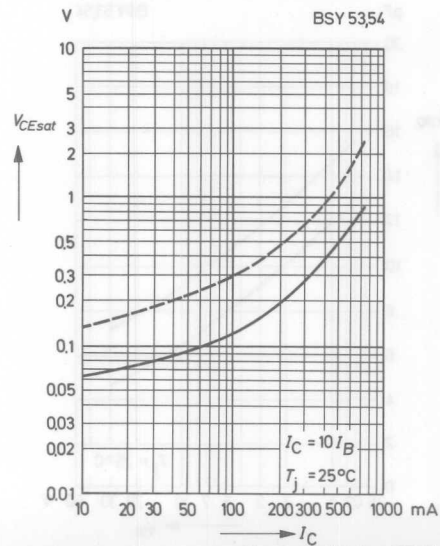
**Admissible power dissipation
versus temperature**



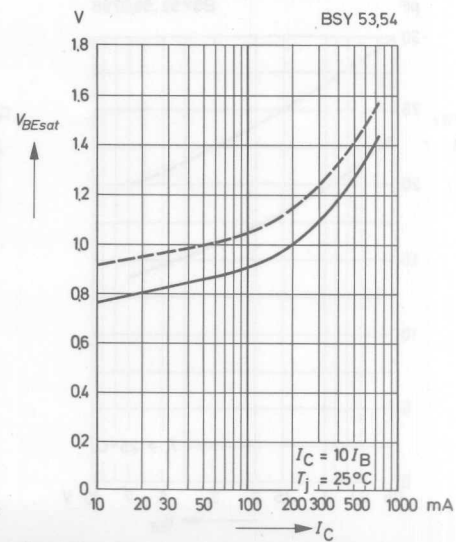
**Relative DC current gain
versus collector current**



**Collector saturation voltage
versus collector current**



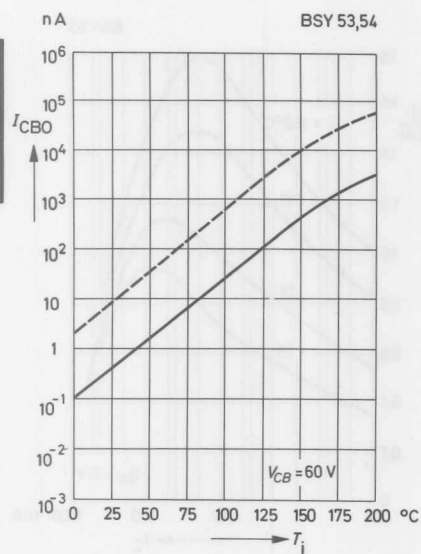
**Base saturation voltage
versus collector current**



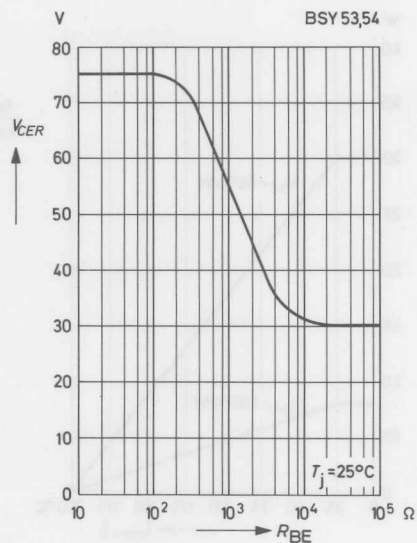
--- upper limit, valid for 95 % of a lot

BSY 53

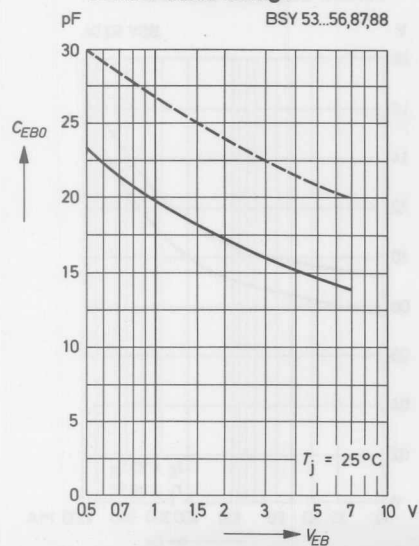
**Collector cutoff current
versus
junction temperature**



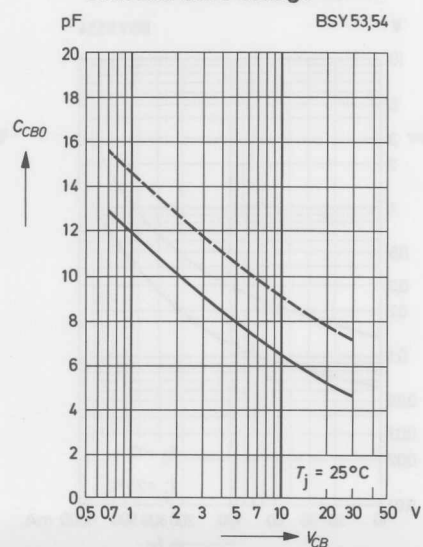
**Admissible collector emitter
voltage versus
base emitter resistance**



**Emitter base capacitance
versus
emitter base voltage**

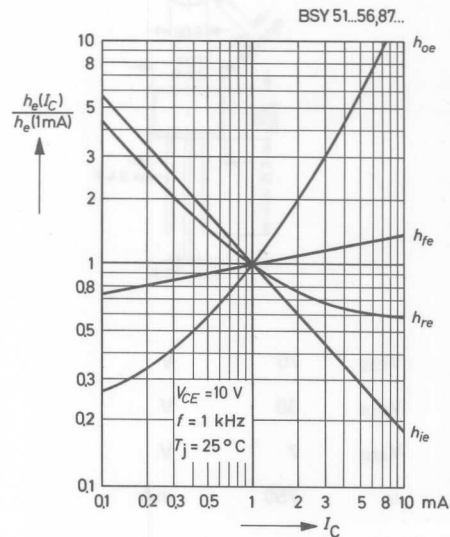


**Collector base capacitance
versus
collector base voltage**

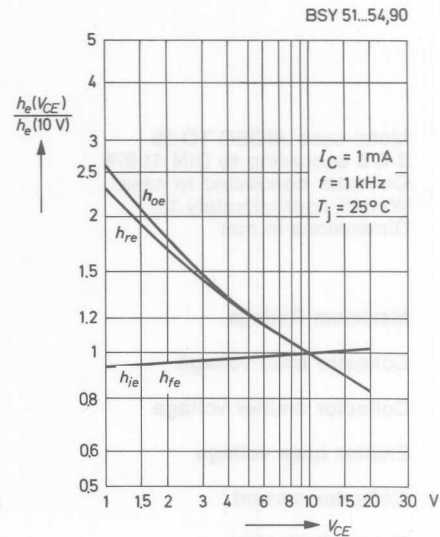


— — — upper limit, valid for 95 % of a lot

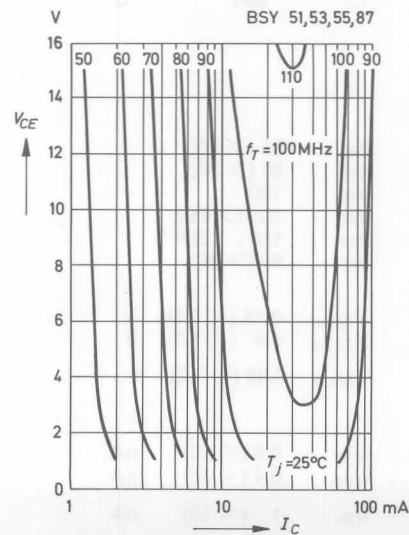
Relative h -parameters
versus
collector current



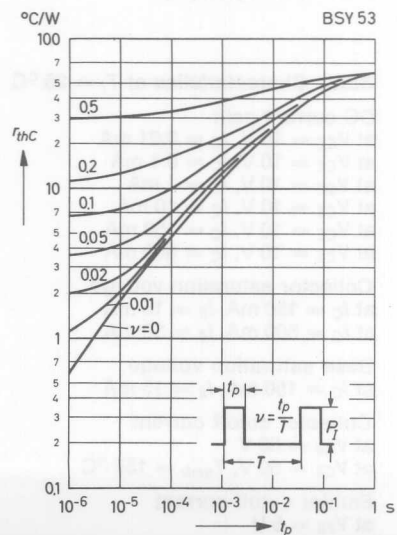
Relative h -parameters
versus
collector emitter voltage



Contours of constant
gain bandwidth product



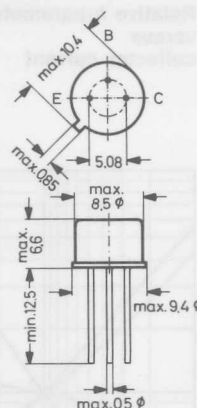
Pulse thermal resistance
versus pulse duration



BSY 54 \approx 2 N 1711

NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	75	V
Collector emitter voltage	V_{CE0}	30	V
Emitter base voltage	V_{EB0}	7	V
Collector current	I_C	750	mA
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 100^\circ\text{C}$	P_{tot}	1.7	W
at $T_C = 25^\circ\text{C}$	P_{tot}	3	W
Junction temperature	T_j	200	$^\circ\text{C}$

Static Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 0.01\text{ mA}$	h_{FE}	55 (> 20)
at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$	h_{FE}	80 (> 35)
at $V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$	h_{FE}	100
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$	h_{FE}	135 (> 80)
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$	h_{FE}	100 ... 300
at $V_{CE} = 10\text{ V}$, $I_C = 500\text{ mA}$	h_{FE}	60 (> 40)

Collector saturation voltage

at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$	$V_{CE\text{ sat}}$	0.15 (< 0.6)	V
at $I_C = 500\text{ mA}$, $I_B = 50\text{ mA}$	$V_{CE\text{ sat}}$	0.5 (< 1.2)	V

Base saturation voltage

at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$	$V_{BE\text{ sat}}$	0.95 (< 1.2)	V
---	---------------------	------------------	---

Collector cutoff current

at $V_{CB} = 60\text{ V}$	I_{CB0}	0.5 (< 10)	nA
at $V_{CB} = 60\text{ V}$, $T_{amb} = 150^\circ\text{C}$	I_{CB0}	0.4 (< 10)	μA

Emitter cutoff current

at $V_{EB} = 5\text{ V}$	I_{EB0}	1 (< 10)	nA
--------------------------	-----------	--------------	----

Collector base capacitance at $V_{CB0} = 10\text{ V}$	C_{CB0}	6.5 (< 10)	pF
Emitter base capacitance at $V_{EB0} = 0.5\text{ V}$	C_{EB0}	23 (< 33)	pF
Thermal resistance Junction to ambient air	$R_{th A}$	< 220	$^{\circ}\text{C/W}$
Junction to case	$R_{th C}$	< 58	$^{\circ}\text{C/W}$

Small Signal Characteristics at $T_{amb} = 25^{\circ}\text{C}$ and $f = 1\text{ kHz}$

Test conditions: $V_{CE} = 5\text{ V}$, $I_C = 1\text{ mA}$, grounded emitter

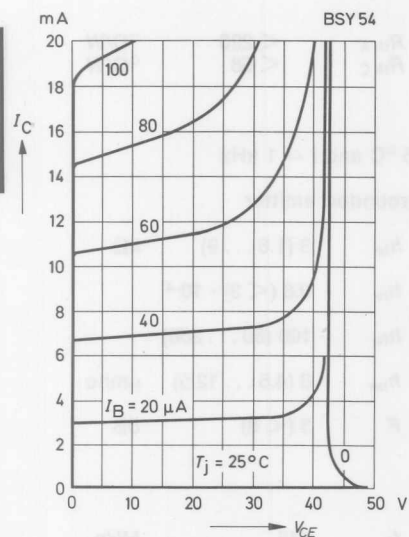
Input impedance	h_{ie}	3 (1.6 ... 9)	$\text{k}\Omega$
Reverse voltage transfer ratio	h_{re}	$0.8 (< 3) \cdot 10^{-4}$	
Small signal current gain	h_{fe}	100 (50 ... 250)	
Output admittance	h_{oe}	8 (4.5 ... 12.5)	μmho
Noise figure at $V_{CE} = 10\text{ V}$, $I_C = 0.3\text{ mA}$, $R_G = 1.5\text{ k}\Omega$, Bandwidth 30 Hz ... 15 kHz	F	3 (< 8)	dB
Gain bandwidth product at $V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$, $f = 50\text{ MHz}$	f_T	145	MHz

Switching Times

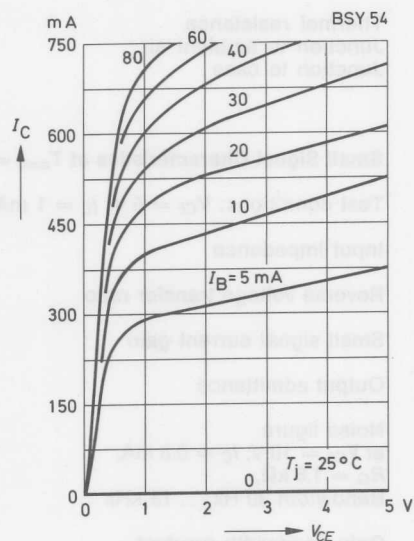
Specifications for switching times of type BSY 51 apply to this type.

BSY 54

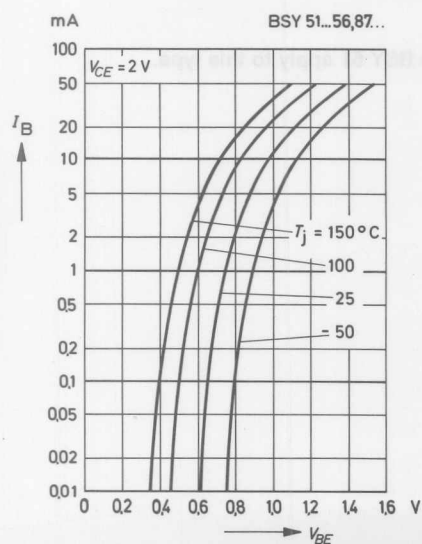
Common emitter
collector characteristics



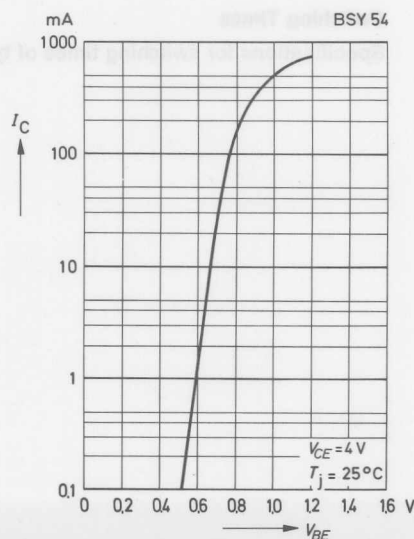
Common emitter
collector characteristics



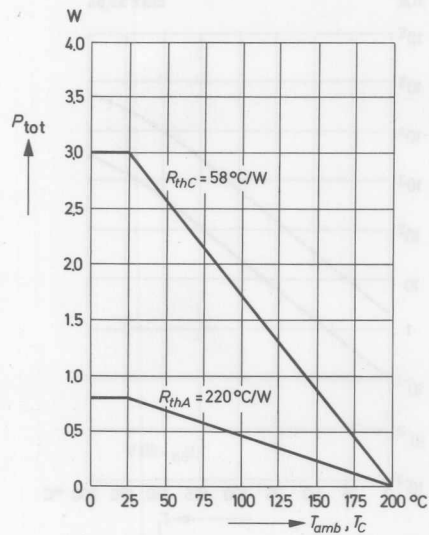
Common emitter
input characteristics



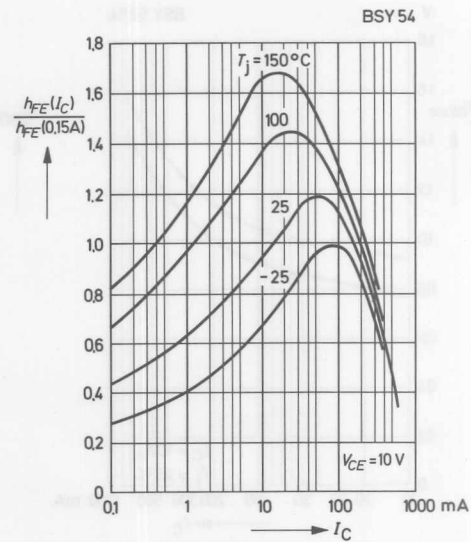
Collector current versus
base emitter voltage



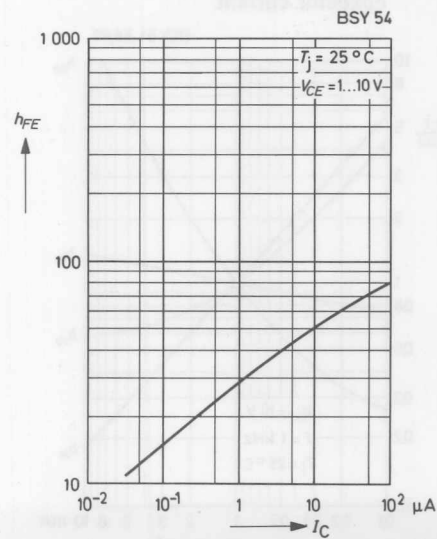
Admissible power dissipation
versus temperature



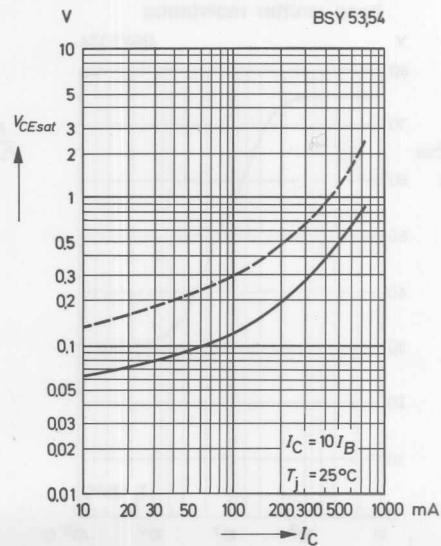
Relative DC current gain
versus collector current



DC current gain versus
small collector current



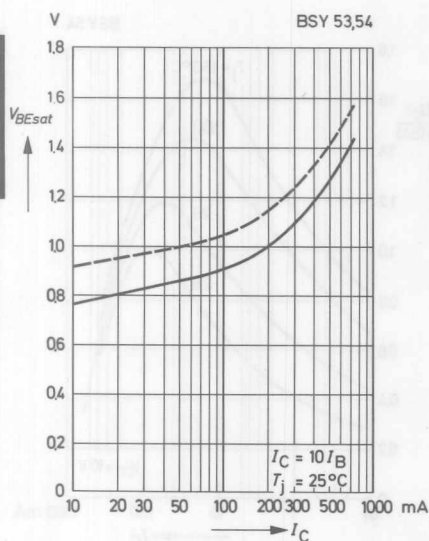
Collector saturation voltage
versus collector current



--- upper limit, valid for 95 % of a lot

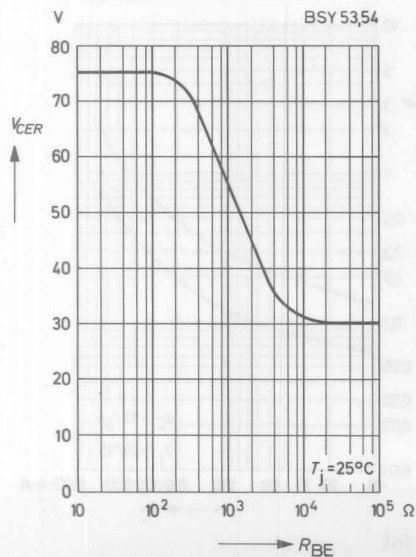
BSY 54

Base saturation voltage
versus collector current

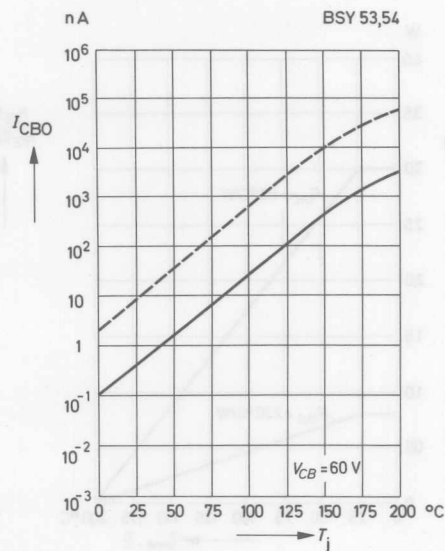


--- upper limit, valid for 95 % of a lot

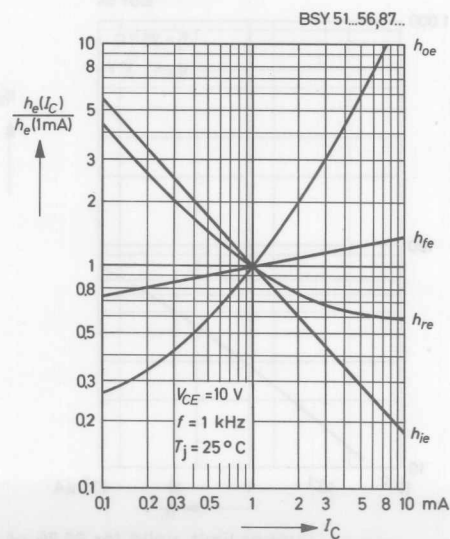
Admissible collector emitter
voltage versus
base emitter resistance



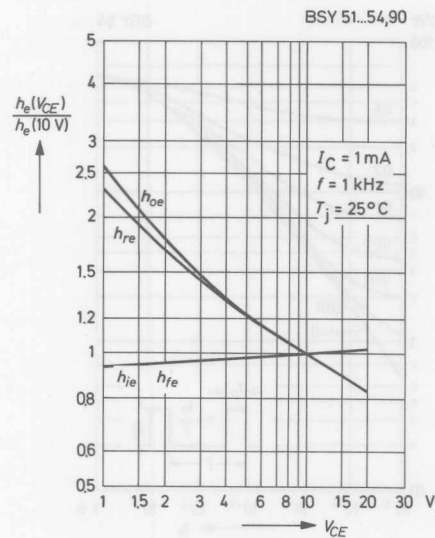
Collector cutoff current
versus junction temperature



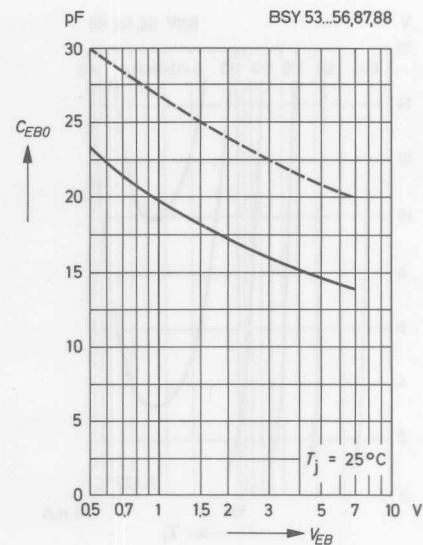
Relative h -parameters
versus
collector current



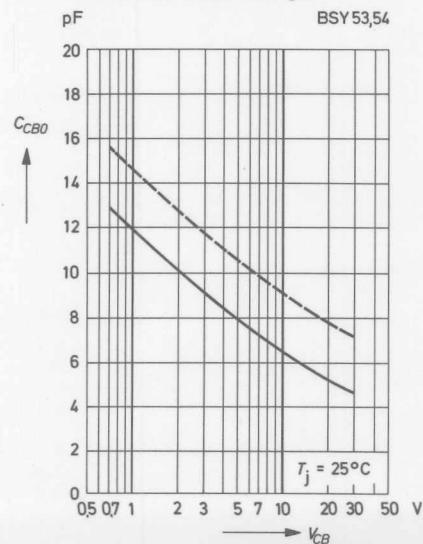
Relative h -parameters
versus
collector emitter voltage



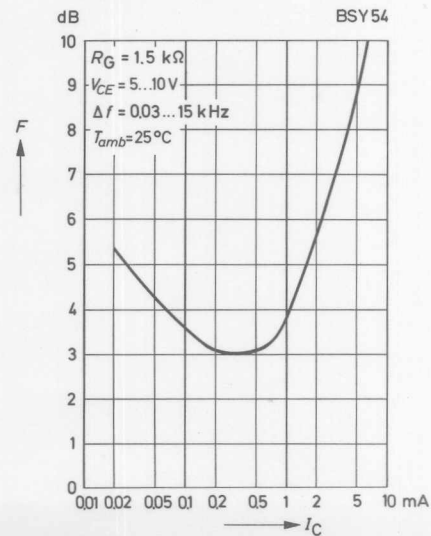
Emitter base capacitance
versus
emitter base voltage



Collector base capacitance
versus
collector base voltage



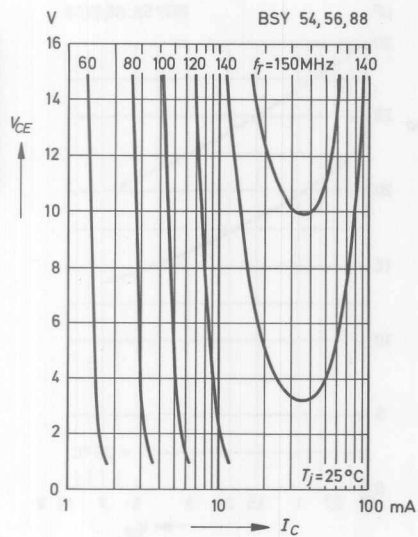
Noise figure
versus
collector current



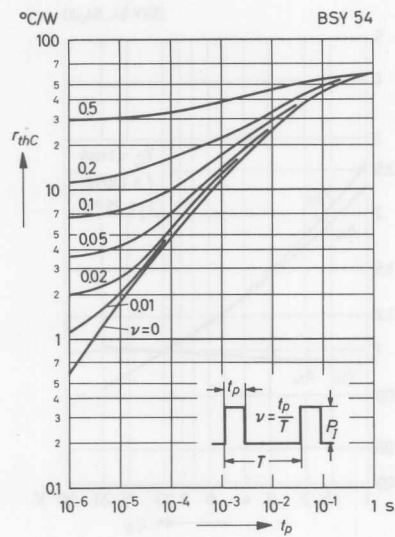
--- upper limit, valid for 95 % of a lot

BSY 54

Contours of constant gain bandwidth product



Pulse thermal resistance versus pulse duration



For more information, please contact your local distributor or the manufacturer.



Model case 3000 10-10
S.C. according to DIN 41812
Collector connected to case
Weight approximately 1 g
Dimensions 4 mm

Maximum Ratings

Collector-base voltage

Collector-emitter voltage

Emitter-base voltage

Collector current

Power dissipation

Function Temperature

Static Characteristics at $T = 25^{\circ}\text{C}$

DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$

at $V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$

at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$

at $V_{CE} = 10\text{ V}$, $I_C = 100\text{ mA}$

at $V_{CE} = 10\text{ V}$, $I_C = 500\text{ mA}$

Collector saturation voltage

at $I_C = 10\text{ mA}$, $V_{BE} = 10\text{ mV}$

at $I_C = 100\text{ mA}$, $V_{BE} = 10\text{ mV}$

Base-emitter voltage

at $I_C = 100\text{ mA}$, $V_{BE} = 10\text{ mV}$

Collector current

at $V_{CE} = 10\text{ V}$, $T_{amb} = 100^{\circ}\text{C}$

Emitter output current

at $V_{CE} = 10\text{ V}$

Collector base resistance

at $V_{CE} = 10\text{ V}$

V_{CE} 100 V

V_{CE} 10 V

V_{CE} 1 V

I_C 100 mA

P_{tot} 0.5 W

P_{tot} 1.7 W

P_{tot} 3 W

P_{tot} 200 W

P_{tot} 200 W

P_{tot} 200 W

P_{tot} 200 W

P_{tot} 200 W

$V_{CE(sat)}$ 0.1 V

$V_{BE(sat)}$ 1 V

$I_{CE(sat)}$ 0.1 A

$I_{CE(sat)}$ 0.1 A

$I_{CE(sat)}$ 0.1 A

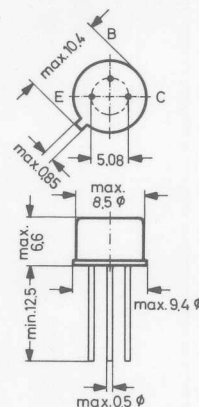
$I_{CE(sat)}$ 0.1 A

$I_{CE(sat)}$ 0.1 A

$I_{CE(sat)}$ 0.1 A

NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm


Maximum Ratings

Collector base voltage	V_{CB0}	120	V
Collector emitter voltage	V_{CE0}	80	V
Emitter base voltage	V_{EB0}	7	V
Collector current	I_C	500	mA
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 100^\circ\text{C}$	P_{tot}	1.7	W
at $T_C = 25^\circ\text{C}$	P_{tot}	3	W
Junction temperature	T_j	200	$^\circ\text{C}$

Static Characteristics at $T_j = 25^\circ\text{C}$

DC current gain			
at $V_{CE} = 10\text{ V}, I_C = 0.1\text{ mA}$	h_{FE}	50 (> 20)	
at $V_{CE} = 10\text{ V}, I_C = 1\text{ mA}$	h_{FE}	60	
at $V_{CE} = 10\text{ V}, I_C = 10\text{ mA}$	h_{FE}	65 (> 35)	
at $V_{CE} = 10\text{ V}, I_C = 150\text{ mA}$	h_{FE}	40 ... 120	
at $V_{CE} = 10\text{ V}, I_C = 500\text{ mA}$	h_{FE}	20	
Collector saturation voltage	$V_{CE\text{ sat}}$	0.2 (< 0.6)	V
at $I_C = 150\text{ mA}, I_B = 15\text{ mA}$			
Base saturation voltage	$V_{BE\text{ sat}}$	1 (< 1.3)	V
at $I_C = 150\text{ mA}, I_B = 15\text{ mA}$			
Collector cutoff current			
at $V_{CB} = 90\text{ V}$	I_{CB0}	0.5 (< 10)	nA
at $V_{CB} = 90\text{ V}, T_{amb} = 150^\circ\text{C}$	I_{CB0}	0.4 (< 10)	μA
Emitter cutoff current	I_{EB0}	1 (< 10)	nA
at $V_{EB} = 5\text{ V}$			
Collector base capacitance	C_{CB0}	6 (< 10)	pF
at $V_{CB0} = 10\text{ V}$			

Emitter base capacitance
at $V_{EB0} = 0.5 \text{ V}$

C_{EB0} 23 (< 33) pF

Thermal resistance
Junction to ambient air
Junction to case

$R_{th A}$ < 220 °C/W
 $R_{th C}$ < 58 °C/W

Small Signal Characteristics at $T_{amb} = 25 \text{ °C}$ and $f = 1 \text{ kHz}$

Test conditions: $V_{CE} = 5 \text{ V}$, $I_C = 1 \text{ mA}$, grounded emitter

Input impedance

h_{ie} 1.6 (0.8 ... 5) kΩ

Reverse voltage transfer ratio

h_{re} $0.6 (< 3) \cdot 10^{-4}$

Small signal current gain

h_{fe} 75 (30 ... 150)

Output admittance

h_{oe} 4 (2 ... 7) μmho

Noise figure

F 6 dB

at $V_{CE} = 10 \text{ V}$, $I_C = 0.3 \text{ mA}$,

$R_G = 1.5 \text{ kΩ}$,

Bandwidth 30 Hz ... 15 kHz

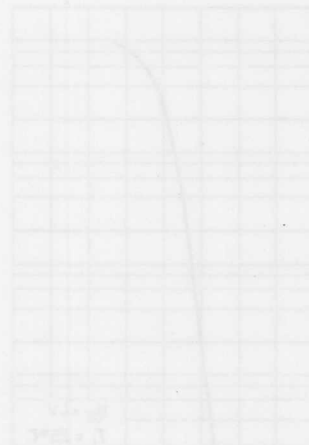
Gain bandwidth product

f_T 100 MHz

at $V_{CE} = 10 \text{ V}$, $I_C = 50 \text{ mA}$, $f = 50 \text{ MHz}$

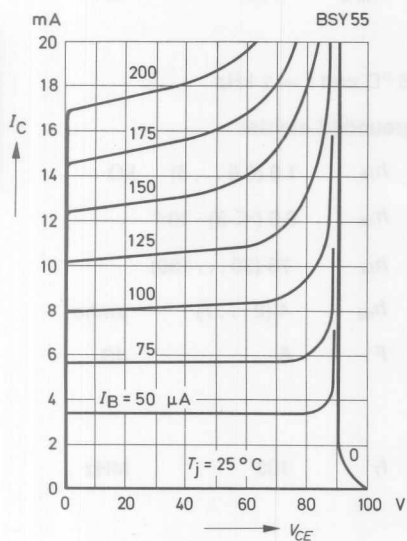
Switching Times

Specifications for switching times of type BSY 51 apply to this type.

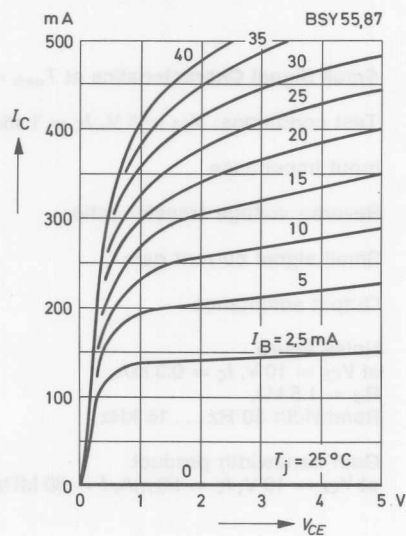


BSY 55

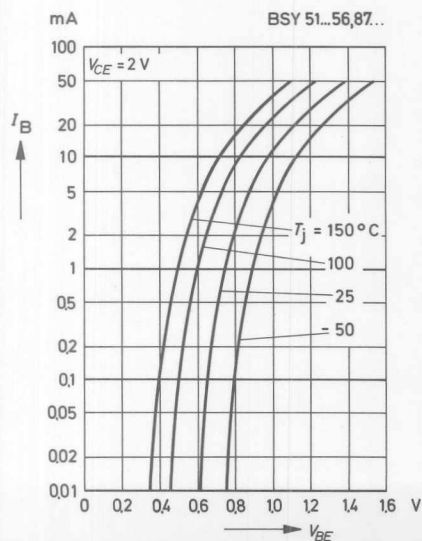
Common emitter
collector characteristics



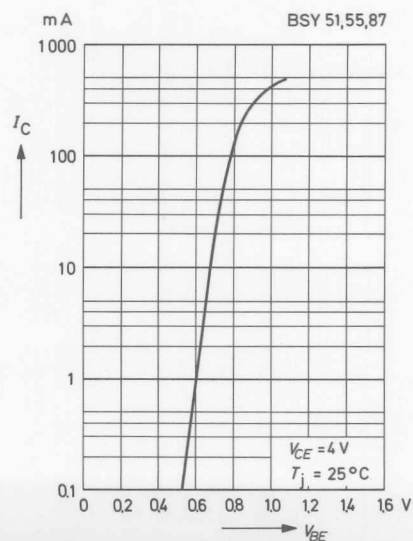
Common emitter
collector characteristics



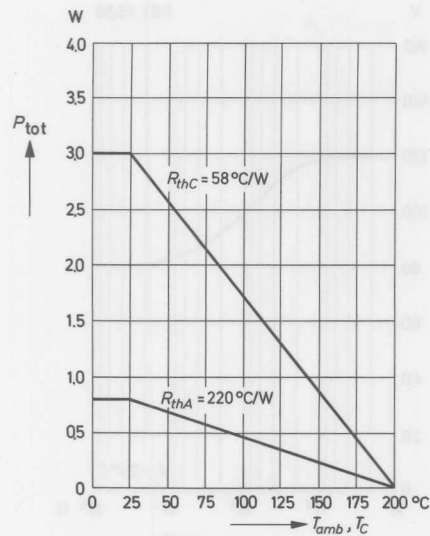
Common emitter
input characteristics



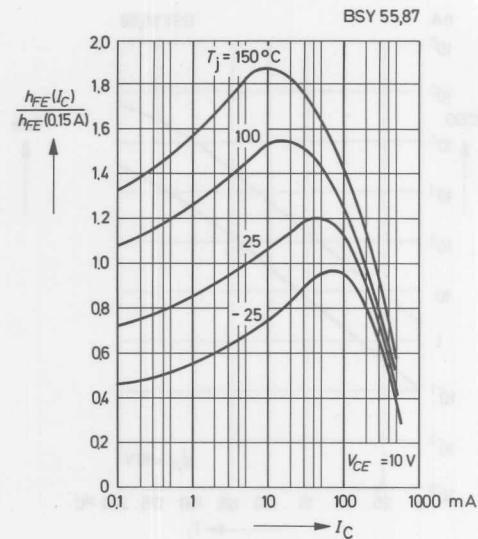
Collector current
versus base emitter voltage



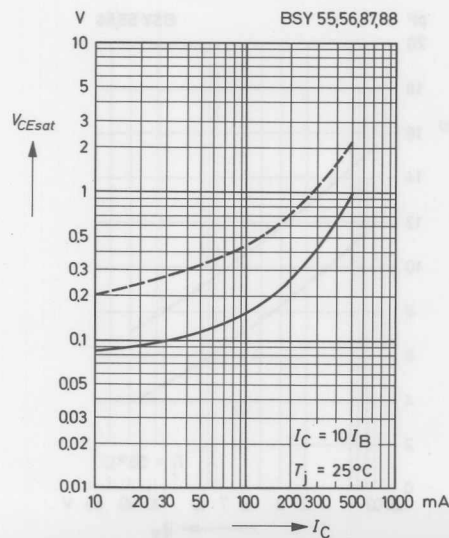
**Admissible power dissipation
versus temperature**



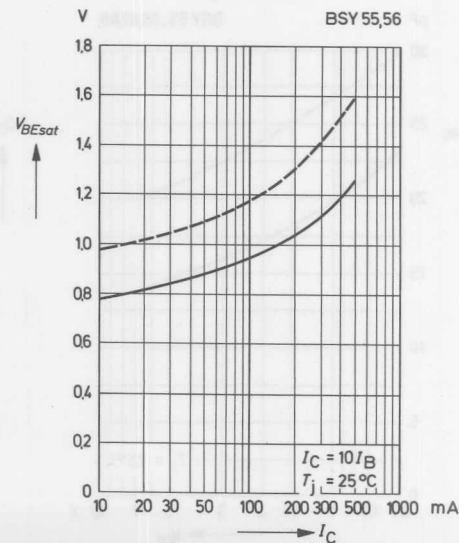
**Relative DC current gain
versus collector current**



**Collector saturation voltage
versus collector current**



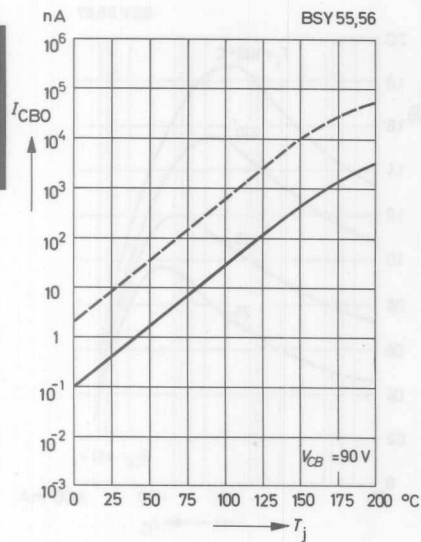
**Base saturation voltage
versus collector current**



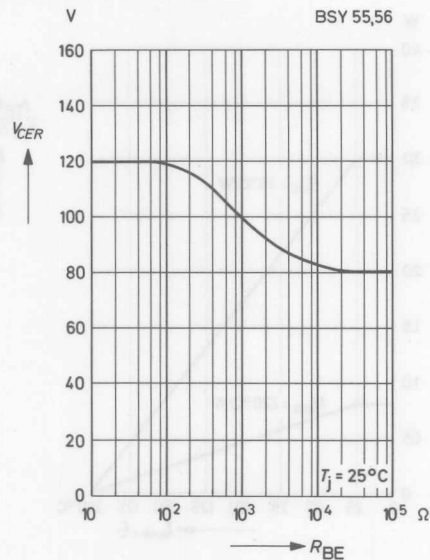
--- upper limit, valid for 95 % of a lot

BSY 55

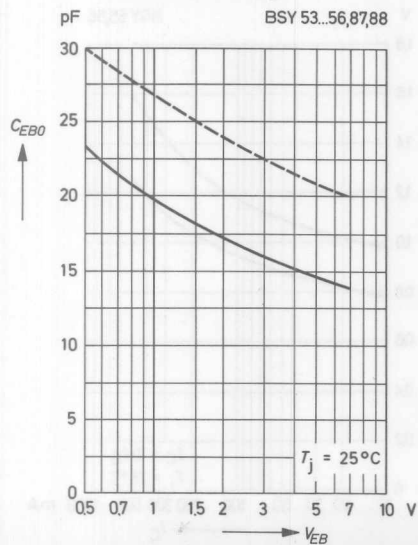
Collector cutoff current
versus
junction temperature



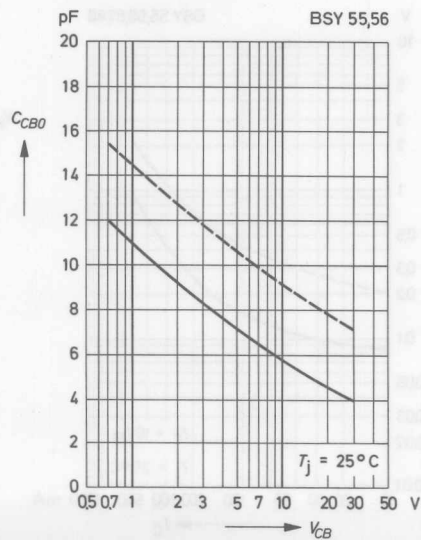
Admissible collector emitter
voltage versus
base emitter resistance



Emitter base capacitance
versus
emitter base voltage

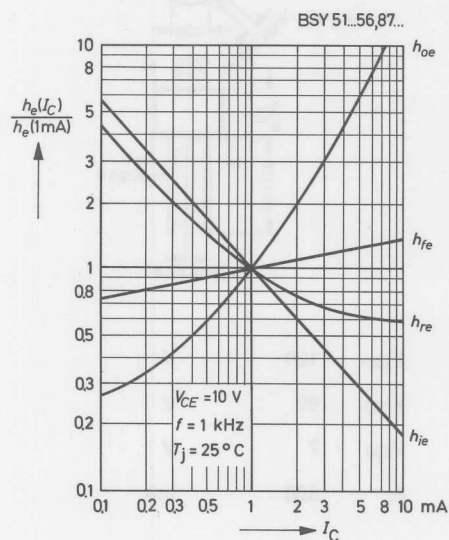


Collector base capacitance
versus
collector base voltage

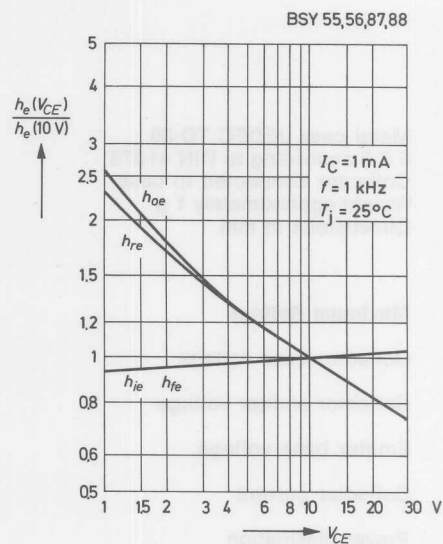


--- upper limit, valid for 95 % of a lot

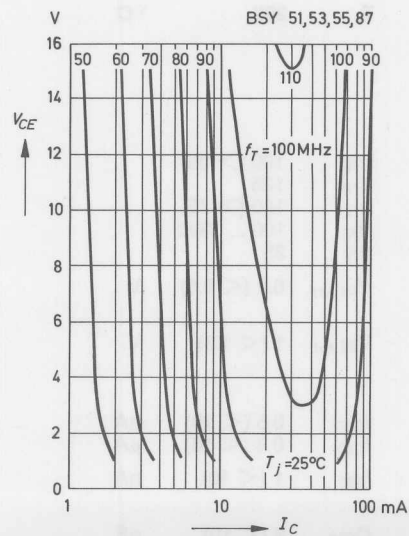
Relative h -parameters
versus
collector current



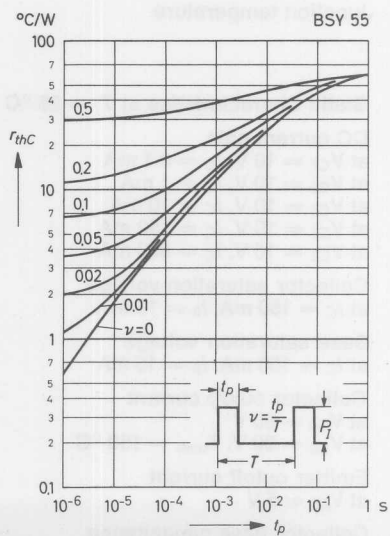
Relative h -parameters
versus
collector emitter voltage



Contours of constant
gain bandwidth product

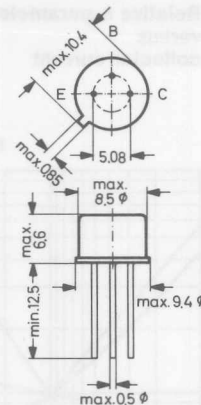


Pulse thermal resistance
versus pulse duration



NPN Silicon Epitaxial Planar Transistor for switching and amplifier applications

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	120	V
Collector emitter voltage	V_{CE0}	80	V
Emitter base voltage	V_{EB0}	7	V
Collector current	I_C	500	mA
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 100^\circ\text{C}$	P_{tot}	1.7	W
at $T_C = 25^\circ\text{C}$	P_{tot}	3	W
Junction temperature	T_i	200	$^\circ\text{C}$

Static Characteristics at $T_i = 25^\circ\text{C}$

DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$	h_{FE}	100 (> 35)
at $V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$	h_{FE}	125
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$	h_{FE}	180 (> 75)
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$	h_{FE}	100 ... 300
at $V_{CE} = 10\text{ V}$, $I_C = 500\text{ mA}$	h_{FE}	35

Collector saturation voltage
at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$

$V_{CE\text{ sat}}$	0.2 (< 0.6)	V
---------------------	-------------	---

Base saturation voltage
at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$

$V_{BE\text{ sat}}$	1 (< 1.3)	V
---------------------	-----------	---

Collector cutoff current

at $V_{CB} = 90\text{ V}$
at $V_{CB} = 90\text{ V}$, $T_{amb} = 150^\circ\text{C}$

I_{CB0}	0.5 (< 10)	nA
I_{CB0}	0.4 (< 10)	μA

Emitter cutoff current
at $V_{EB} = 5\text{ V}$

I_{EB0}	1 (< 10)	nA
-----------	----------	----

Collector base capacitance
at $V_{CB0} = 10\text{ V}$

C_{CB0}	6 (< 10)	pF
-----------	----------	----

Emitter base capacitance
at $V_{EB0} = 0.5 \text{ V}$

C_{EB0} 23 (< 33) pF

Thermal resistance
Junction to ambient air
Junction to case

R_{thA} < 220 °C/W
 R_{thC} < 58 °C/W

Small Signal Characteristics at $T_{amb} = 25 \text{ °C}$ and $f = 1 \text{ kHz}$

Test conditions: $V_{CE} = 5 \text{ V}$, $I_C = 1 \text{ mA}$, grounded emitter

Input impedance

h_{ie} 3 (1.6 ... 9) kΩ

Reverse voltage transfer ratio

h_{re} $0.6 (< 3) \cdot 10^{-4}$

Small signal current gain

h_{fe} 120 (60 ... 280)

Output admittance

h_{oe} 6 (3 ... 10) μmho

Noise figure

F 6 dB

at $V_{CE} = 10 \text{ V}$, $I_C = 0.3 \text{ mA}$,
 $R_G = 1.5 \text{ kΩ}$,

Bandwidth 30 Hz ... 15 kHz

Gain bandwidth product

f_T 145 MHz

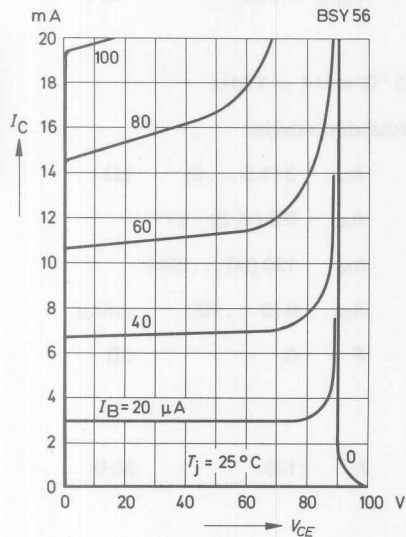
at $V_{CE} = 10 \text{ V}$, $I_C = 50 \text{ mA}$, $f = 50 \text{ MHz}$

Switching Times

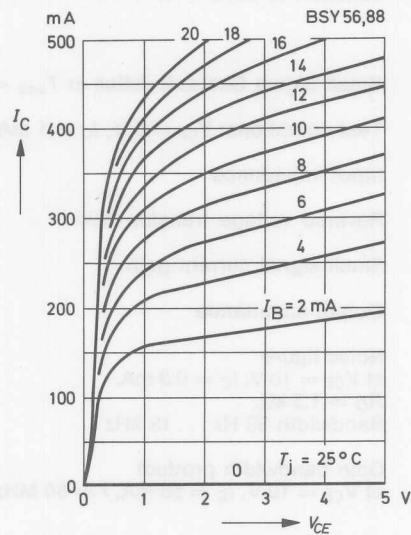
Specifications for switching times of type BSY 51 apply to this type.

BSY 56

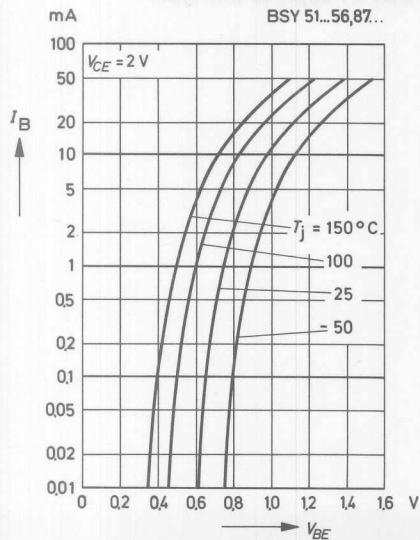
Common emitter
collector characteristics



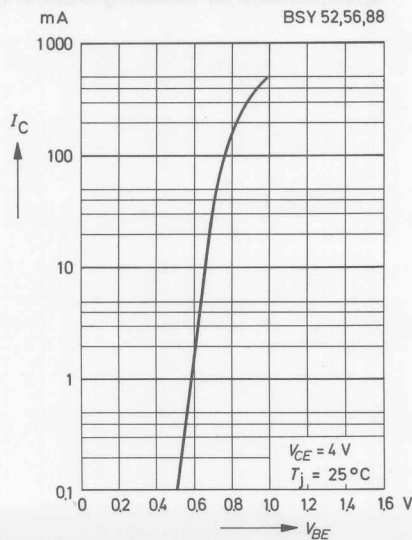
Common emitter
collector characteristics



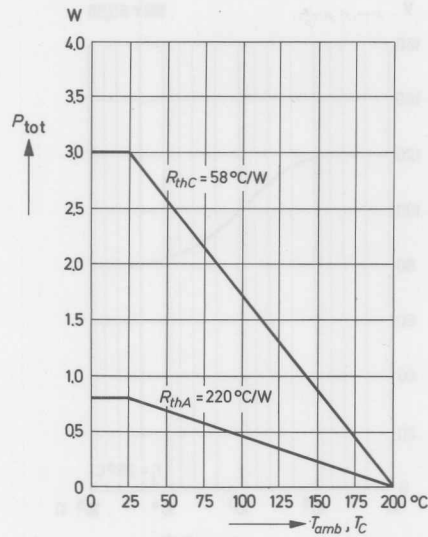
Common emitter
input characteristics



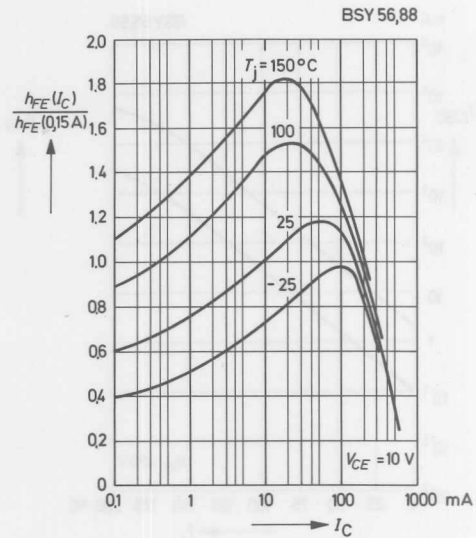
Collector current
versus base emitter voltage



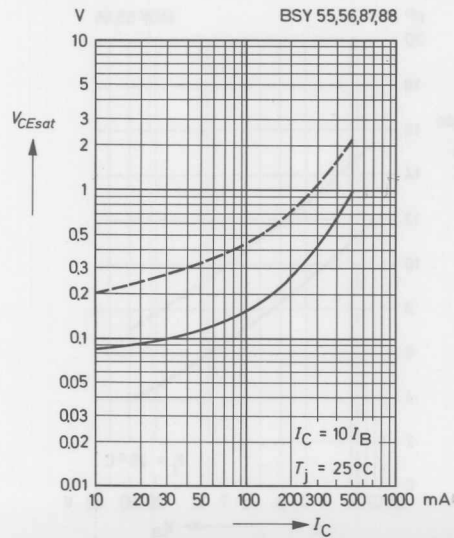
**Admissible power dissipation
versus temperature**



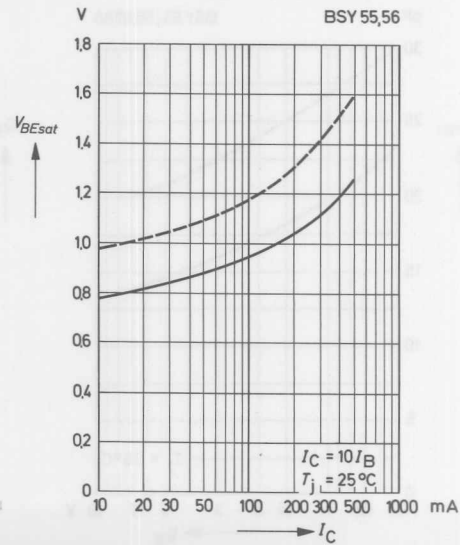
**Relative DC current gain
versus collector current**



**Collector saturation voltage
versus collector current**



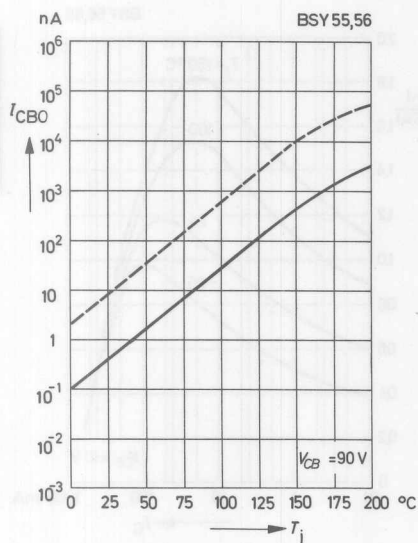
**Base saturation voltage
versus collector current**



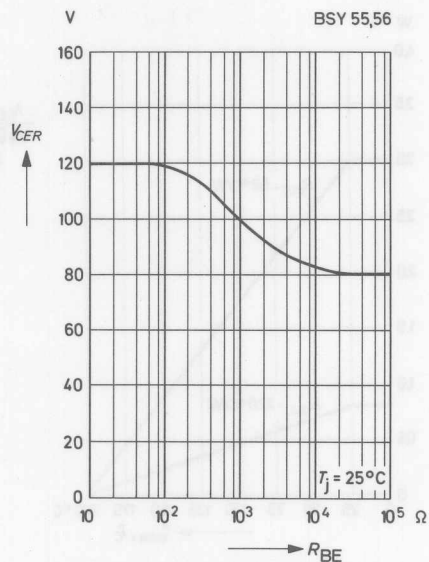
--- upper limit, valid for 95 % of a lot

BSY 56

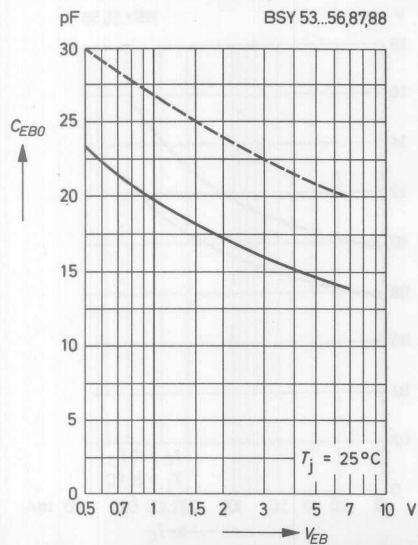
**Collector cutoff current
versus
junction temperature**



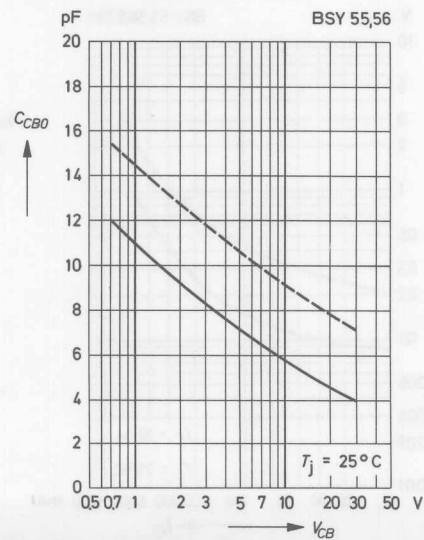
**Admissible collector emitter
voltage versus
base emitter resistance**



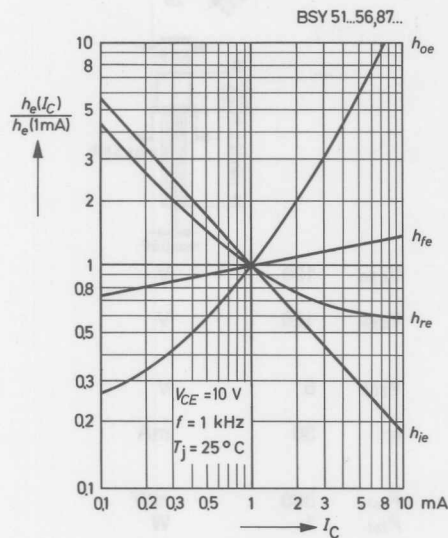
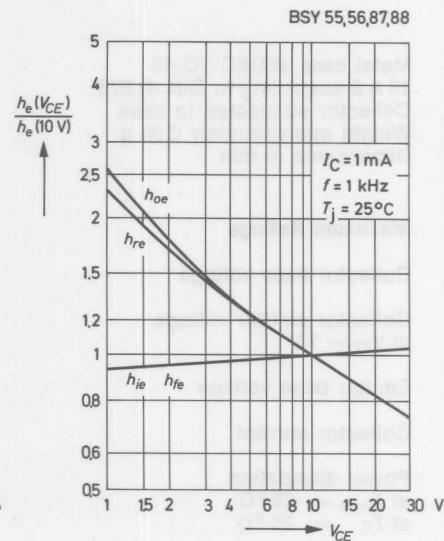
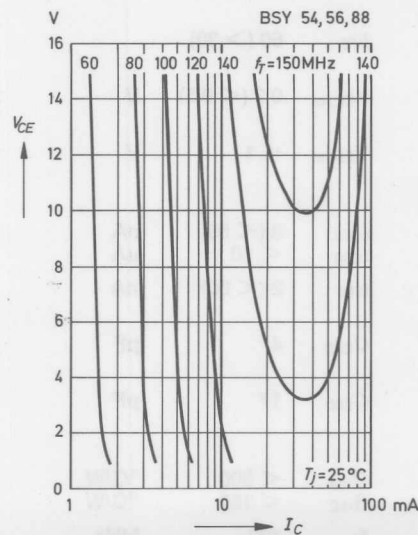
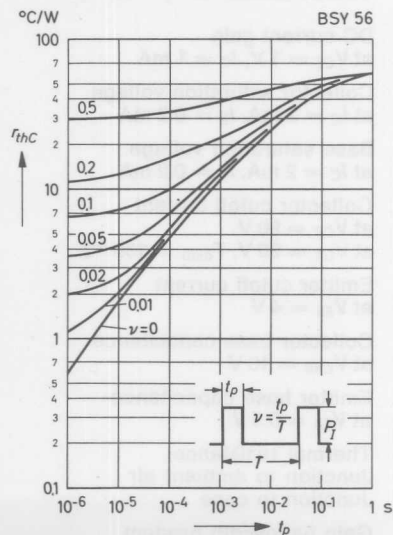
**Emitter base capacitance
versus
emitter base voltage**



**Collector base capacitance
versus
collector base voltage**



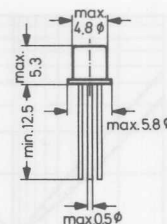
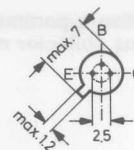
--- upper limit, valid for 95 % of a lot

Relative h -parameters
versus collector currentRelative h -parameters
versus collector emitter voltageContours of constant
gain bandwidth productPulse thermal resistance
versus pulse duration

BSY 79

NPN Silicon Epitaxial Planar Transistor

with high collector emitter voltage for use as driver
for numerical indicator tubes (Nixie driver)



Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

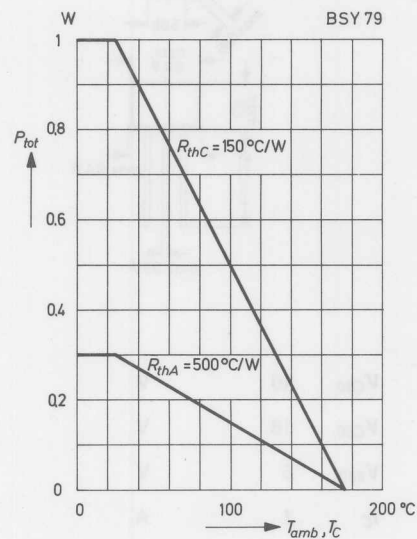
Maximum Ratings

Collector base voltage	V_{CB0}	120	V
Collector emitter voltage at $V_{EB} = 1$ V	V_{CEV}	120	V
Emitter base voltage	V_{EB0}	5	V
Collector current	I_C	30	mA
Power dissipation at $T_{amb} = 25$ °C	P_{tot}	300	mW
at $T_C = 25$ °C	P_{tot}	1	W
Junction temperature	T_j	175	°C

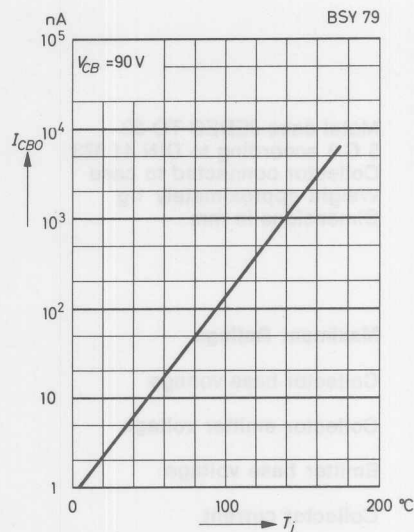
Characteristics at $T_j = 25$ °C

DC current gain at $V_{CE} = 1$ V, $I_C = 1$ mA	h_{FE}	60 (> 30)	
Collector saturation voltage at $I_C = 2$ mA, $I_B = 0.2$ mA	$V_{CE sat}$	0.3 (< 0.5)	V
Base saturation voltage at $I_C = 2$ mA, $I_B = 0.2$ mA	$V_{BE sat}$	< 1	V
Collector cutoff current at $V_{CB} = 90$ V	I_{CB0}	3 (< 50)	nA
at $V_{CB} = 90$ V, $T_{amb} = 150$ °C	I_{CB0}	< 10	μA
Emitter cutoff current at $V_{EB} = 4$ V	I_{EB0}	2 (< 50)	nA
Collector base capacitance at $V_{CB0} = 10$ V	C_{CB0}	4	pF
Emitter base capacitance at $V_{EB} = 0.5$ V	C_{EB0}	17	pF
Thermal resistance Junction to ambient air	R_{thA}	< 500	°C/W
Junction to case	R_{thC}	< 150	°C/W
Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 10$ mA, $f = 50$ MHz	f_T	100	MHz

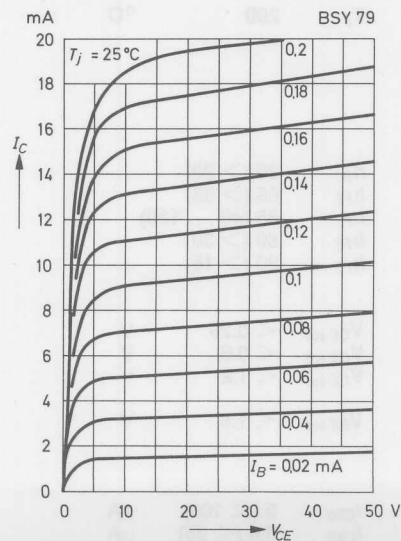
**Admissible power dissipation
versus temperature**



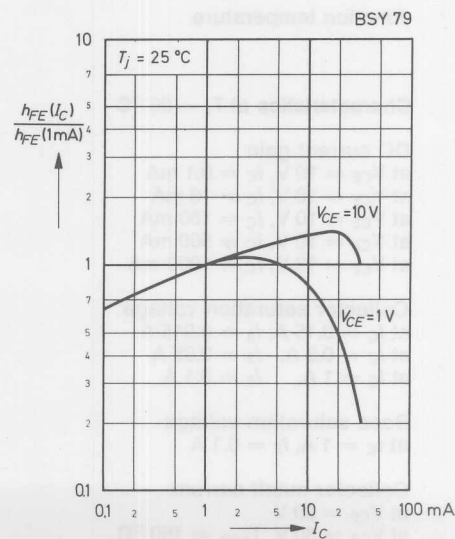
**Collector cutoff current
versus junction temperature**



**Common emitter
collector characteristics**



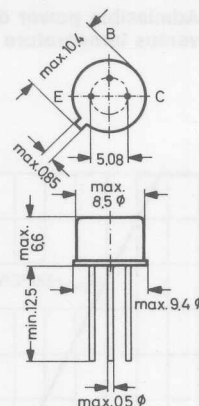
**Relative DC current gain
versus collector current**



BSY 81

NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications
at higher collector current

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	40	V
Collector emitter voltage	V_{CE0}	18	V
Emitter base voltage	V_{EB0}	5	V
Collector current	I_C	1	A
Power dissipation			
at $T_{amb} = 25\text{ }^{\circ}\text{C}$	P_{tot}	0.9	W
at $T_C = 100\text{ }^{\circ}\text{C}$	P_{tot}	2.8	W
at $T_C = 25\text{ }^{\circ}\text{C}$	P_{tot}	5	W
Junction temperature	T_j	200	$^{\circ}\text{C}$

Characteristics at $T_j = 25\text{ }^{\circ}\text{C}$

DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$
at $V_{CE} = 10\text{ V}$, $I_C = 500\text{ mA}$
at $V_{CE} = 10\text{ V}$, $I_C = 1000\text{ mA}$

h_{FE}	30 (> 20)
h_{FE}	65 (> 35)
h_{FE}	85 (40 ... 120)
h_{FE}	60 (> 30)
h_{FE}	30 (> 15)

Collector saturation voltage

at $I_C = 0.15\text{ A}$, $I_B = 0.015\text{ A}$
at $I_C = 0.5\text{ A}$, $I_B = 0.05\text{ A}$
at $I_C = 1\text{ A}$, $I_B = 0.1\text{ A}$

$V_{CE\text{ sat}}$	< 0.25	V
$V_{CE\text{ sat}}$	< 0.6	V
$V_{CE\text{ sat}}$	< 1.2	V

Base saturation voltage

at $I_C = 1\text{ A}$, $I_B = 0.1\text{ A}$

$V_{BE\text{ sat}}$	< 1.8	V
---------------------	-------	---

Collector cutoff current

at $V_{CB} = 30\text{ V}$
at $V_{CB} = 30\text{ V}$, $T_{amb} = 150\text{ }^{\circ}\text{C}$

I_{CB0}	2 (< 100)	nA
I_{CB0}	0.6 (< 25)	μA

Emitter cutoff current
at $V_{EB} = 3 \text{ V}$

I_{EBO} 3 (< 10) nA

Collector base capacitance
at $V_{CB0} = 10 \text{ V}$

C_{CB0} 8.5 (< 15) pF

Emitter base capacitance
at $V_{EB0} = 0.5 \text{ V}$

C_{EB0} 50 (< 60) pF

Gain bandwidth product
at $V_{CE} = 10 \text{ V}$, $I_C = 50 \text{ mA}$, $f = 50 \text{ MHz}$

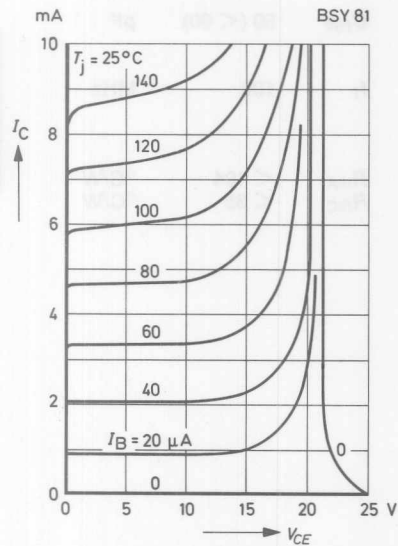
f_T 100 MHz

Thermal resistance
Junction to ambient air
Junction to case

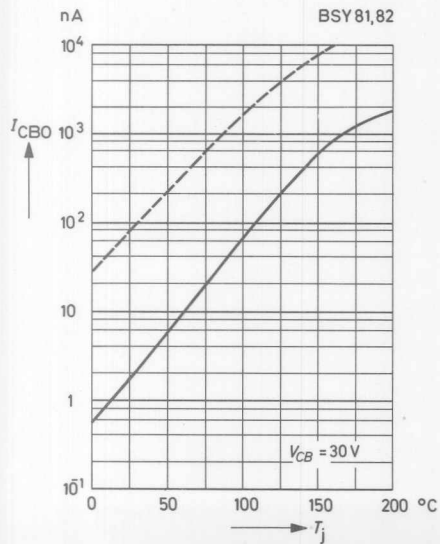
R_{thA} < 194 $^{\circ}\text{C/W}$
 R_{thC} < 35 $^{\circ}\text{C/W}$

BSY 81

Common emitter
collector characteristics

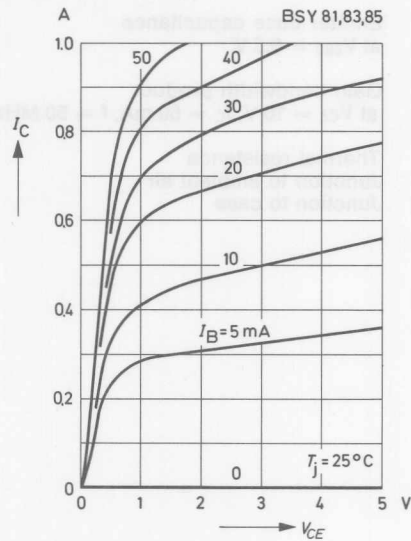


Collector cutoff current
versus junction temperature

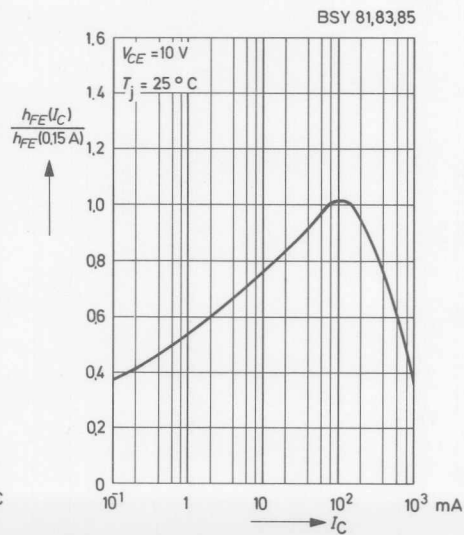


--- upper limit, valid for 95 % of a lot

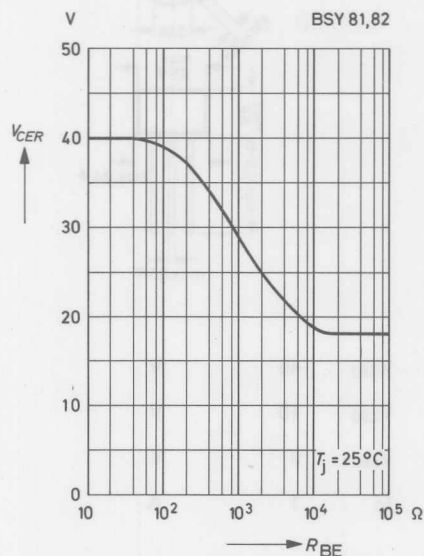
Common emitter
collector characteristics



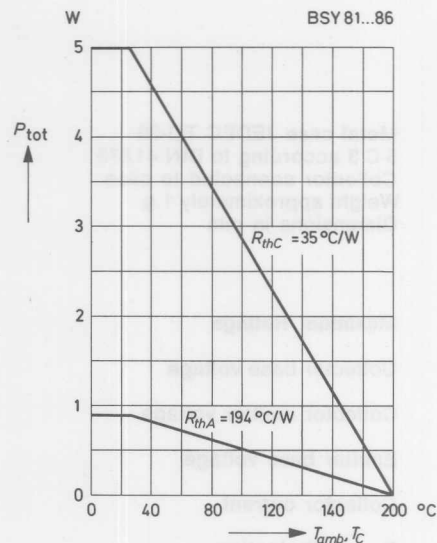
Relative DC current gain
versus collector current



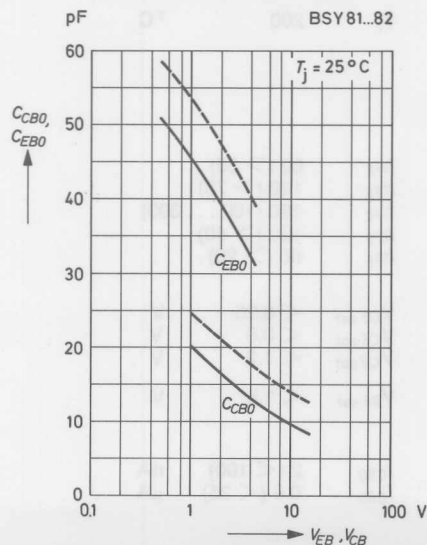
Admissible collector emitter voltage versus base emitter resistance



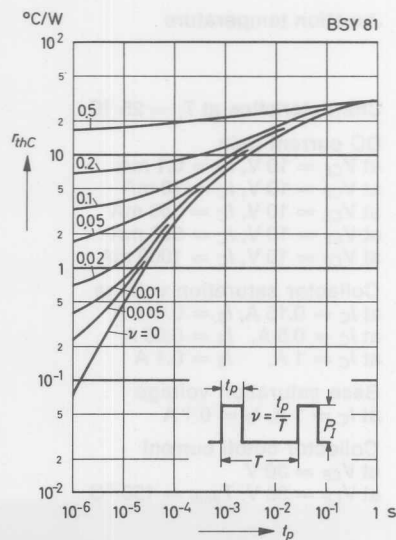
Admissible power dissipation versus temperature



Collector base capacitance, Emitter base capacitance versus reverse bias voltage



Pulse thermal resistance versus pulse duration

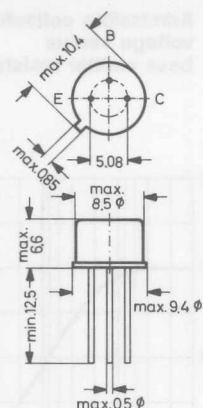


--- upper limit, valid for 95 % of a lot

BSY 82

NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications
at higher collector current

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	40	V
Collector emitter voltage	V_{CE0}	18	V
Emitter base voltage	V_{EB0}	5	V
Collector current	I_C	1	A
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.9	W
at $T_C = 100^\circ\text{C}$	P_{tot}	2.8	W
at $T_C = 25^\circ\text{C}$	P_{tot}	5	W
Junction temperature	T_j	200	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$

at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$

at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$

at $V_{CE} = 10\text{ V}$, $I_C = 500\text{ mA}$

at $V_{CE} = 10\text{ V}$, $I_C = 1000\text{ mA}$

h_{FE}	60 (> 35)
h_{FE}	140 (> 75)
h_{FE}	190 (100 ... 300)
h_{FE}	120 (> 40)
h_{FE}	50 (> 20)

Collector saturation voltage

at $I_C = 0.15\text{ A}$, $I_B = 0.015\text{ A}$

at $I_C = 0.5\text{ A}$, $I_B = 0.05\text{ A}$

at $I_C = 1\text{ A}$, $I_B = 0.1\text{ A}$

$V_{CE\text{ sat}}$	< 0.25	V
$V_{CE\text{ sat}}$	< 0.6	V
$V_{CE\text{ sat}}$	< 1.2	V

Base saturation voltage

at $I_C = 1\text{ A}$, $I_B = 0.1\text{ A}$

$V_{BE\text{ sat}}$	< 1.8	V
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Collector cutoff current

at $V_{CB} = 30\text{ V}$

at $V_{CB} = 30\text{ V}$, $T_{amb} = 150^\circ\text{C}$

I_{CB0}	2 (< 100)	nA
I_{CB0}	0.6 (< 25)	μA

Emitter cutoff current
at $V_{EB} = 3 \text{ V}$

I_{EB0} 3 (< 10) nA

Collector base capacitance
at $V_{CB0} = 10 \text{ V}$

C_{CB0} 8.5 (< 15) pF

Emitter base capacitance
at $V_{EB0} = 0.5 \text{ V}$

C_{EB0} 50 (< 60) pF

Gain bandwidth product
at $V_{CE} = 10 \text{ V}$, $I_C = 50 \text{ mA}$, $f = 50 \text{ MHz}$

f_T 120 MHz

Thermal resistance

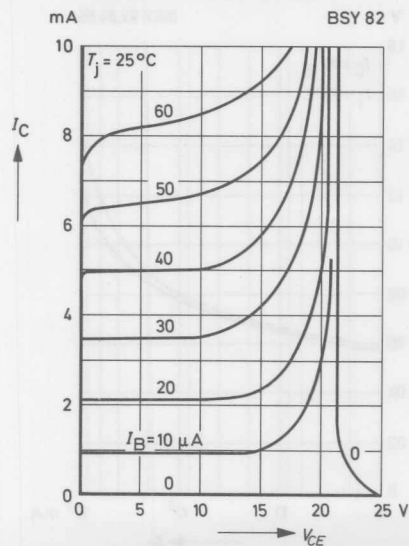
Junction to ambient air

R_{thA} < 194 °C/W

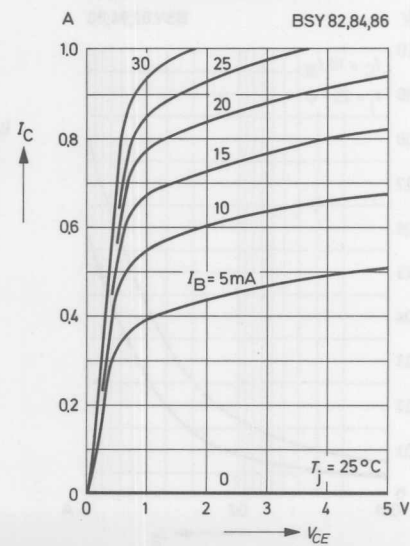
Junction to case

R_{thC} < 35 °C/W

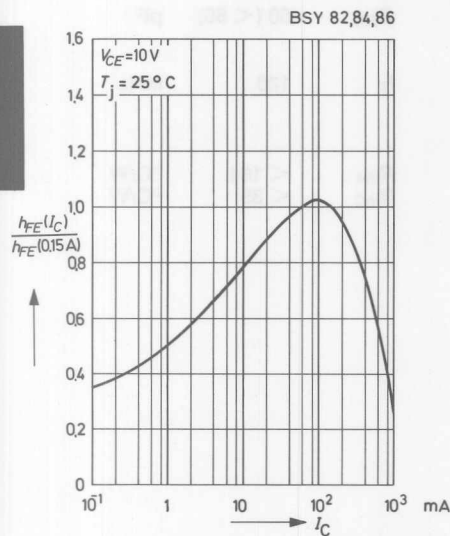
Common emitter
collector characteristics



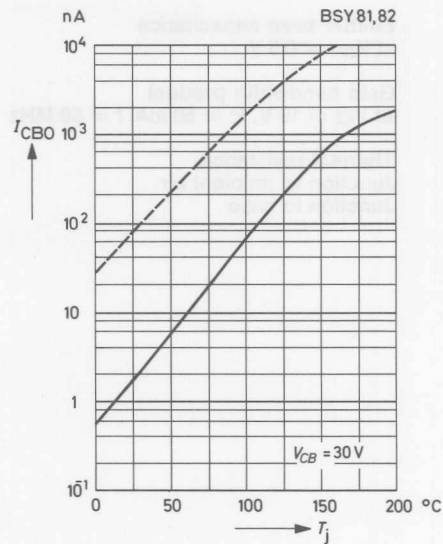
Common emitter
collector characteristics



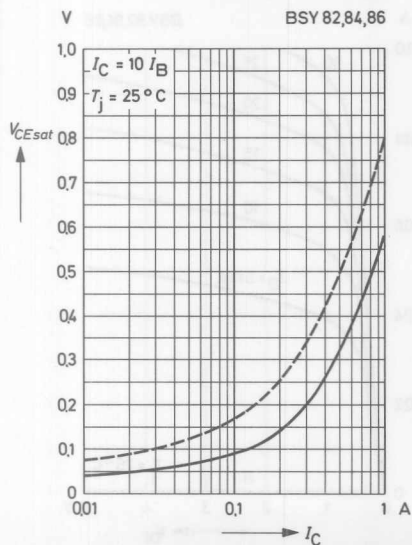
**Relative DC current gain
versus collector current**



**Collector cutoff current
versus junction temperature**

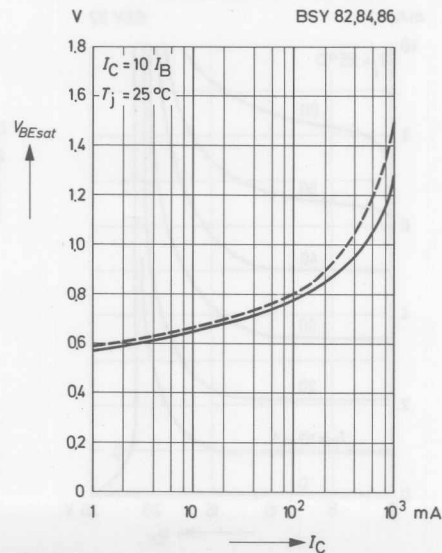


**Collector saturation voltage
versus collector current**

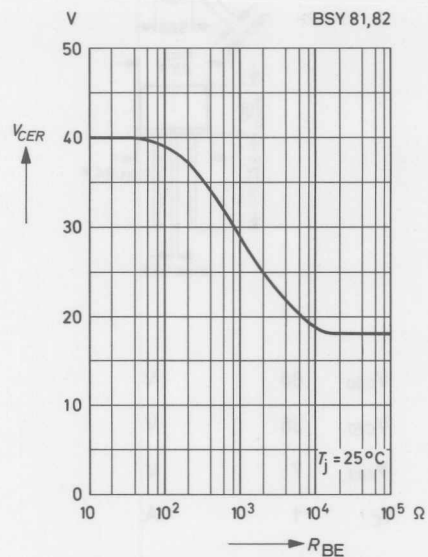


--- upper limit, valid for 95 % of a lot

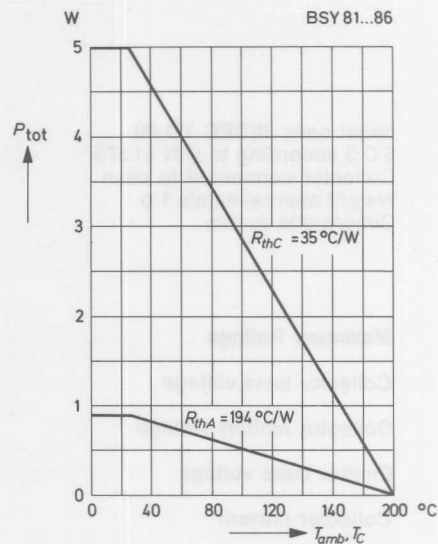
**Base saturation voltage
versus collector current**



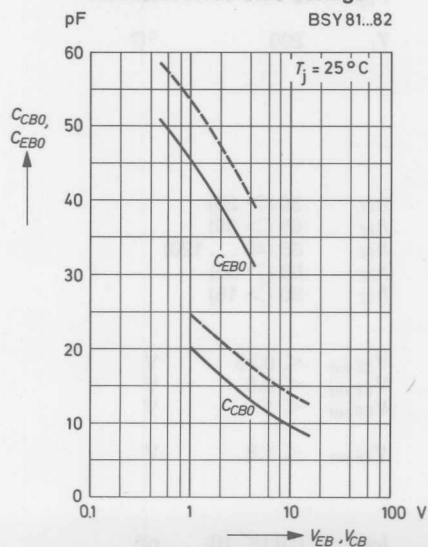
Admissible collector emitter
voltage versus
base emitter resistance



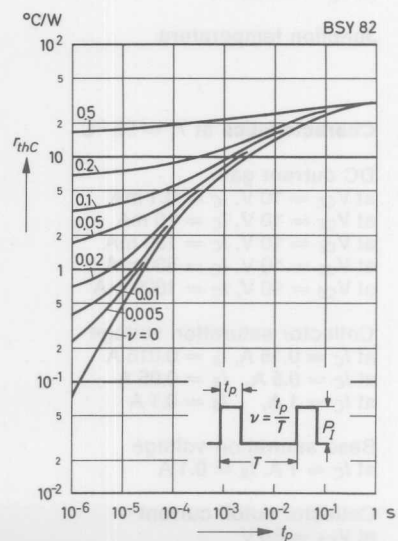
Admissible power dissipation
versus temperature



Collector base capacitance,
Emitter base capacitance
versus reverse bias voltage



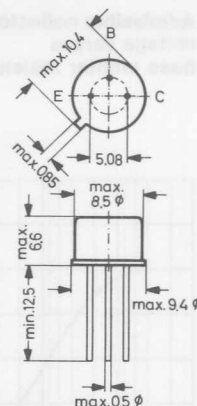
Pulse thermal resistance
versus pulse duration



--- upper limit, valid for 95 % of a lot

NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications
at higher collector current

Metal case JEDEC TO-39
5 C 3 according to DIN 41873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	80	V
Collector emitter voltage	V_{CE0}	35	V
Emitter base voltage	V_{EB0}	7	V
Collector current	I_C	1	A
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.9	W
at $T_C = 100^\circ\text{C}$	P_{tot}	2.8	W
at $T_C = 25^\circ\text{C}$	P_{tot}	5	W
Junction temperature	T_j	200	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$	h_{FE}	30 (> 20)
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$	h_{FE}	65 (> 35)
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$	h_{FE}	85 (40 ... 120)
at $V_{CE} = 10\text{ V}$, $I_C = 500\text{ mA}$	h_{FE}	60 (> 30)
at $V_{CE} = 10\text{ V}$, $I_C = 1000\text{ mA}$	h_{FE}	30 (> 15)

Collector saturation voltage

at $I_C = 0.15\text{ A}$, $I_B = 0.015\text{ A}$	$V_{CE\text{ sat}}$	< 0.25	V
at $I_C = 0.5\text{ A}$, $I_B = 0.05\text{ A}$	$V_{CE\text{ sat}}$	< 0.6	V
at $I_C = 1\text{ A}$, $I_B = 0.1\text{ A}$	$V_{CE\text{ sat}}$	< 1	V

Base saturation voltage

at $I_C = 1\text{ A}$, $I_B = 0.1\text{ A}$	$V_{BE\text{ sat}}$	< 1.8	V
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Collector cutoff current

at $V_{CB} = 60\text{ V}$	I_{CB0}	0.6 (< 10)	nA
at $V_{CB} = 60\text{ V}$, $T_{amb} = 150^\circ\text{C}$	I_{CB0}	0.3 (< 10)	μA

Emitter cutoff current
at $V_{EB} = 3 \text{ V}$

I_{EB0} 5 (< 10) nA

Collector base capacitance
at $V_{CB0} = 10 \text{ V}$

C_{CB0} 8.5 (< 15) pF

Emitter base capacitance
at $V_{EB0} = 0.5 \text{ V}$

C_{EB0} 50 (< 60) pF

Gain bandwidth product
at $V_{CE} = 10 \text{ V}$, $I_C = 50 \text{ mA}$, $f = 50 \text{ MHz}$

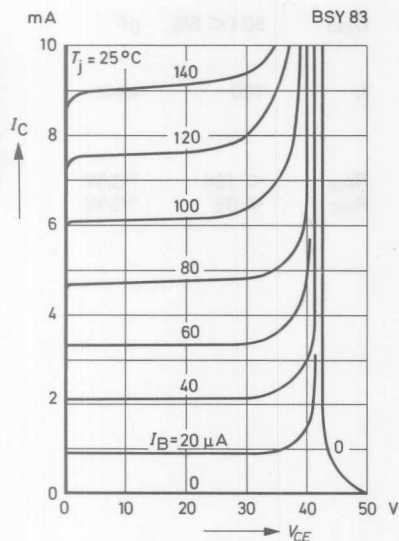
f_T 100 MHz

Thermal resistance
Junction to ambient air
Junction to case

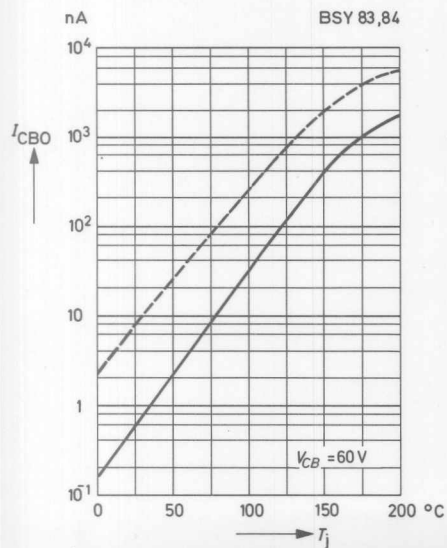
R_{thA} < 194 °C/W
 R_{thC} < 35 °C/W

BSY 83

Common emitter collector characteristics

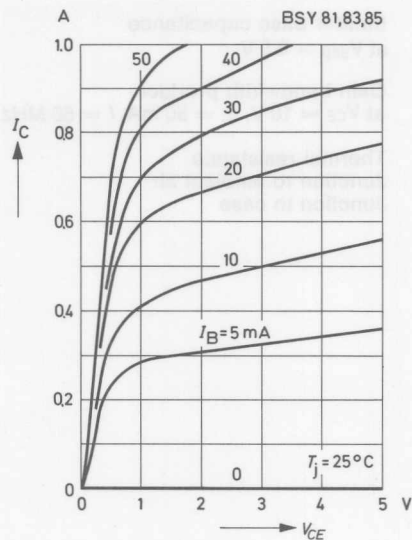


Collector cutoff current versus junction temperature

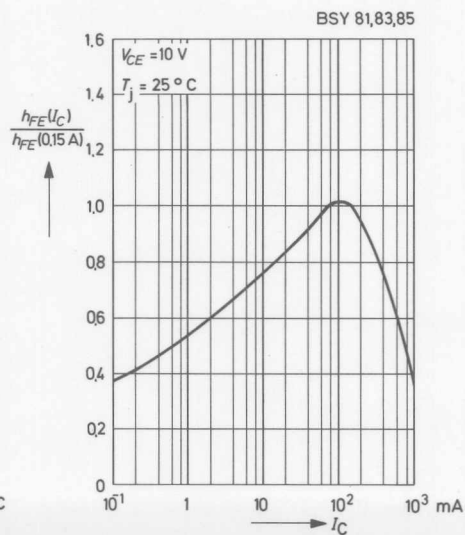


----- upper limit, valid for 95 % of a lot

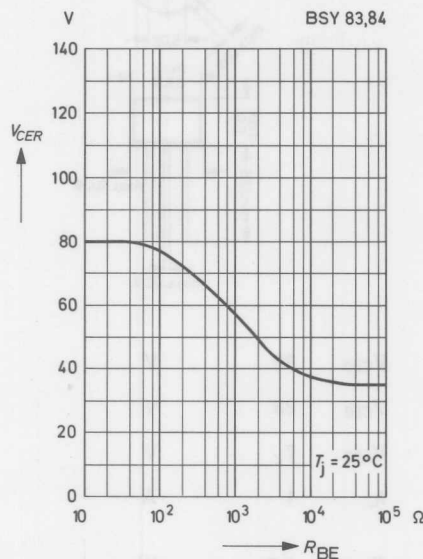
Common emitter collector characteristics



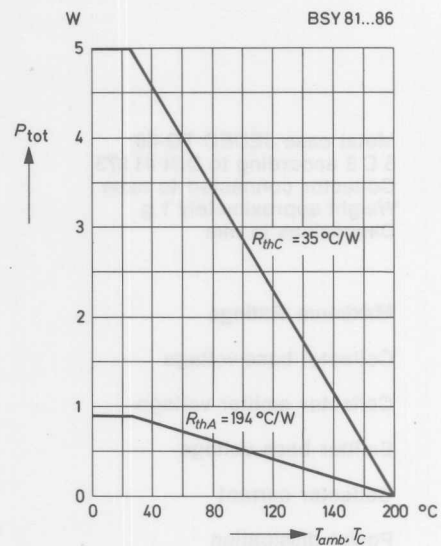
Relative DC current gain versus collector current



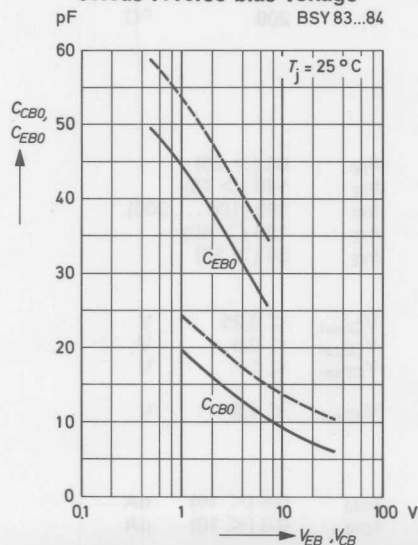
Admissible collector emitter voltage versus base emitter resistance



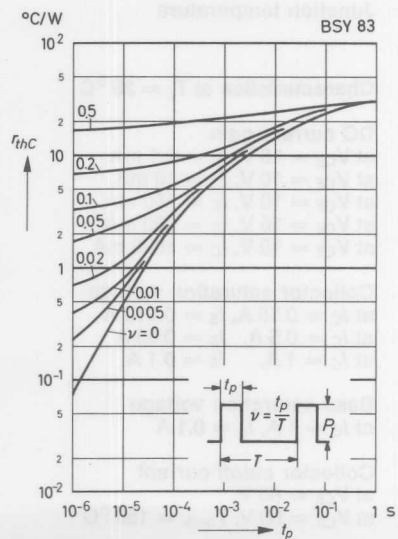
Admissible power dissipation versus temperature



Collector emitter capacitance, Emitter base capacitance versus reverse bias voltage



Pulse thermal resistance versus pulse duration

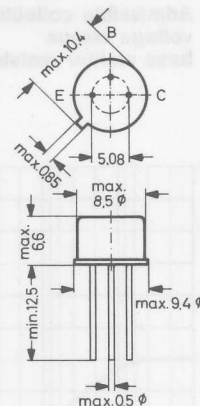


--- upper limit, valid for 95 % of a lot

BSY 84

NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications
at higher collector current

Metal case JEDEC TO-39
5 C 3 according to DIN 41873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	80	V
Collector emitter voltage	V_{CE0}	35	V
Emitter base voltage	V_{EB0}	7	V
Collector current	I_C	1	A
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.9	W
at $T_C = 100^\circ\text{C}$	P_{tot}	2.8	W
at $T_C = 25^\circ\text{C}$	P_{tot}	5	W
Junction temperature	T_j	200	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$	h_{FE}	60 (> 35)
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$	h_{FE}	140 (> 75)
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$	h_{FE}	190 (100 ... 300)
at $V_{CE} = 10\text{ V}$, $I_C = 500\text{ mA}$	h_{FE}	120 (> 40)
at $V_{CE} = 10\text{ V}$, $I_C = 1000\text{ mA}$	h_{FE}	50 (> 20)

Collector saturation voltage

at $I_C = 0.15\text{ A}$, $I_B = 0.015\text{ A}$	$V_{CE\text{ sat}}$	< 0.25	V
at $I_C = 0.5\text{ A}$, $I_B = 0.05\text{ A}$	$V_{CE\text{ sat}}$	< 0.6	V
at $I_C = 1\text{ A}$, $I_B = 0.1\text{ A}$	$V_{CE\text{ sat}}$	< 1	V

Base saturation voltage

at $I_C = 1\text{ A}$, $I_B = 0.1\text{ A}$	$V_{BE\text{ sat}}$	< 1.8	V
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Collector cutoff current

at $V_{CB} = 60\text{ V}$	I_{CB0}	0.6 (< 10)	nA
at $V_{CB} = 60\text{ V}$, $T_{amb} = 150^\circ\text{C}$	I_{CB0}	0.3 (< 10)	μA

Emitter cutoff current
at $V_{EB} = 3 \text{ V}$

I_{EBO} 5 (< 10) nA

Collector base capacitance
at $V_{CB0} = 10 \text{ V}$

C_{CB0} 8.5 (< 15) pF

Emitter base capacitance
at $V_{EB0} = 0.5 \text{ V}$

C_{EB0} 50 (< 60) pF

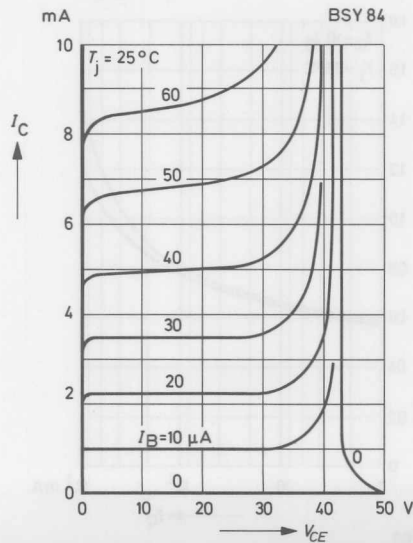
Gain bandwidth product
at $V_{CE} = 10 \text{ V}$, $I_C = 50 \text{ mA}$, $f = 50 \text{ MHz}$

f_T 120 MHz

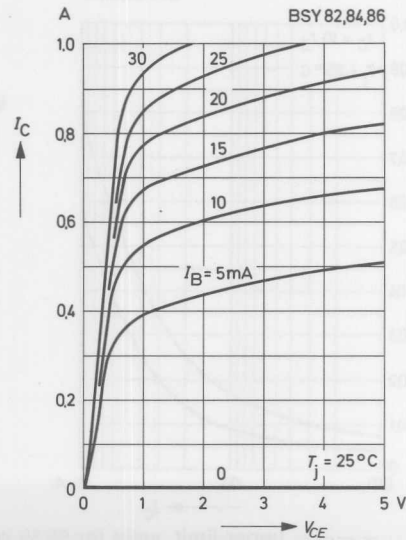
Thermal resistance
Junction to ambient air
Junction to case

R_{thA} < 194 °C/W
 R_{thC} < 35 °C/W

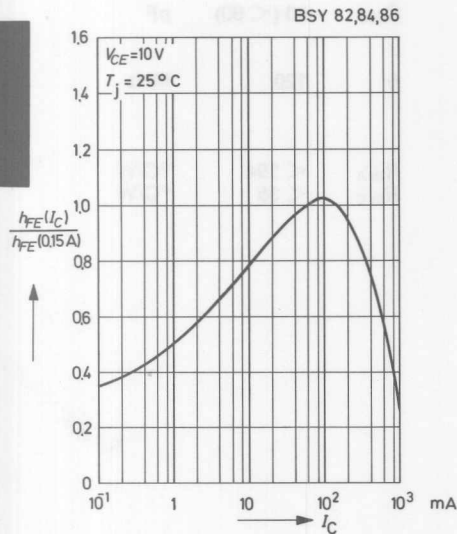
Common emitter
collector characteristics



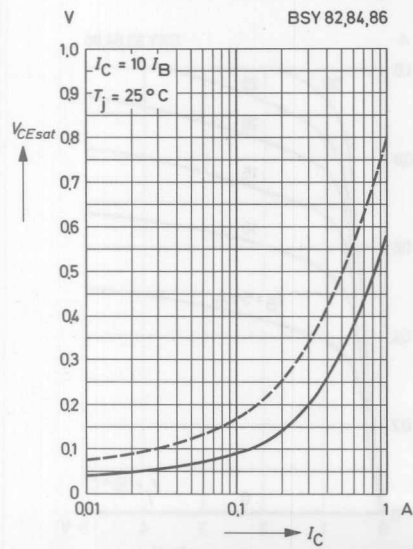
Common emitter
collector characteristics



**Relative DC current gain
versus collector current**

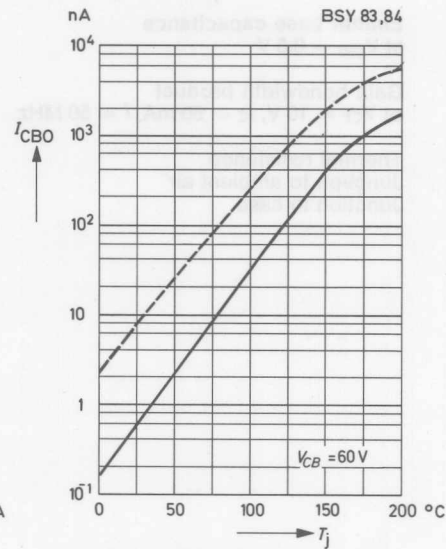


**Collector saturation voltage
versus collector current**

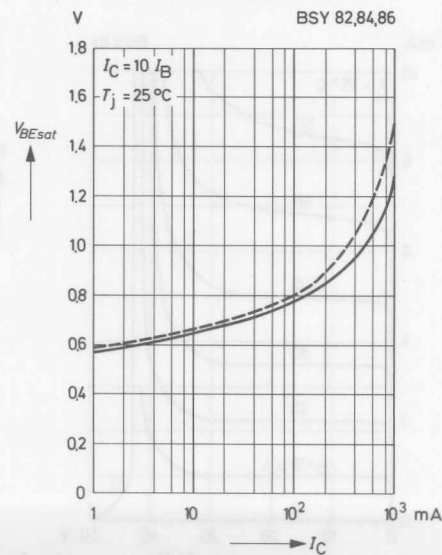


--- upper limit, valid for 95 % of a lot

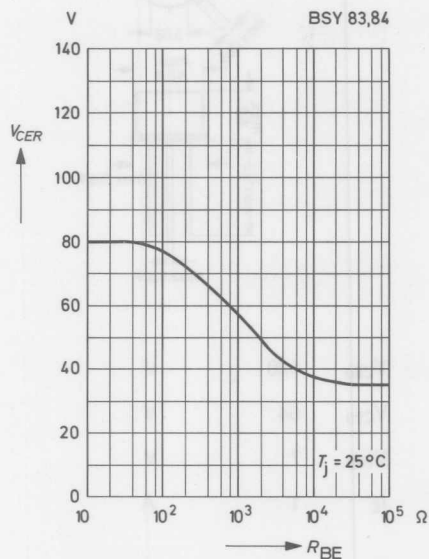
**Collector cutoff current
versus junction temperature**



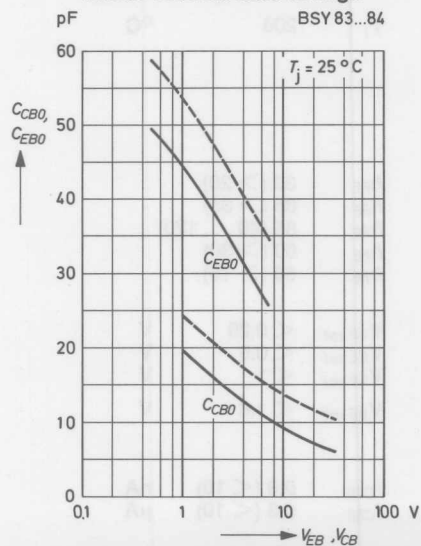
**Base saturation voltage
versus collector current**



Admissible collector emitter
voltage versus
base emitter resistance

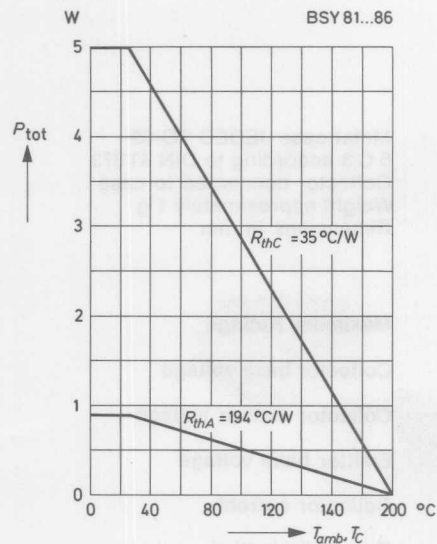


Collector base capacitance,
Emitter base capacitance
versus reverse bias voltage

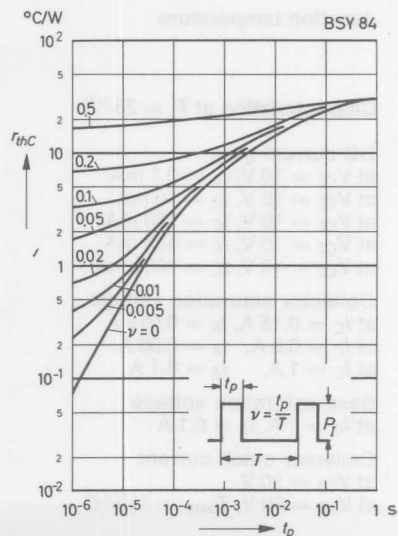


--- upper limit, valid for 95 % of a lot

Admissible power dissipation
versus temperature



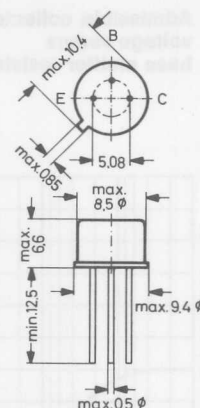
Pulse thermal resistance
versus pulse duration



BSY 85 \approx 2 N 2193 A

NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications
at higher collector current

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	120	V
Collector emitter voltage	V_{CE0}	64	V
Emitter base voltage	V_{EB0}	7	V
Collector current	I_C	1	A
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.9	W
at $T_C = 100^\circ\text{C}$	P_{tot}	2.8	W
at $T_C = 25^\circ\text{C}$	P_{tot}	5	W
Junction temperature	T_j	200	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$	h_{FE}	30 (> 20)
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$	h_{FE}	65 (> 35)
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$	h_{FE}	85 (40 ... 120)
at $V_{CE} = 10\text{ V}$, $I_C = 500\text{ mA}$	h_{FE}	60 (> 30)
at $V_{CE} = 10\text{ V}$, $I_C = 1000\text{ mA}$	h_{FE}	30 (> 15)

Collector saturation voltage

at $I_C = 0.15\text{ A}$, $I_B = 0.015\text{ A}$	$V_{CE sat}$	< 0.25	V
at $I_C = 0.5\text{ A}$, $I_B = 0.05\text{ A}$	$V_{CE sat}$	< 0.6	V
at $I_C = 1\text{ A}$, $I_B = 0.1\text{ A}$	$V_{CE sat}$	< 1	V

Base saturation voltage

at $I_C = 1\text{ A}$, $I_B = 0.1\text{ A}$	$V_{BE sat}$	< 1.8	V
--	--------------	---------	---

Collector cutoff current

at $V_{CB} = 90\text{ V}$	I_{CB0}	0.6 (< 10)	nA
at $V_{CB} = 90\text{ V}$, $T_{amb} = 150^\circ\text{C}$	I_{CB0}	0.3 (< 10)	μA

Emitter cutoff current
at $V_{EB} = 3 \text{ V}$

I_{EBO} 5 (< 10) nA

Collector base capacitance
at $V_{CB0} = 10 \text{ V}$

C_{CB0} 8.5 (< 15) pF

Emitter base capacitance
at $V_{EB0} = 0.5 \text{ V}$

C_{EB0} 50 (< 60) pF

Gain bandwidth product
at $V_{CE} = 10 \text{ V}$, $I_C = 50 \text{ mA}$, $f = 50 \text{ MHz}$

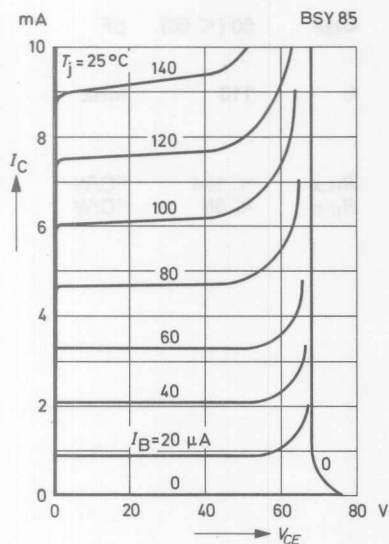
f_T 110 MHz

Thermal resistance
Junction to ambient air
Junction to case

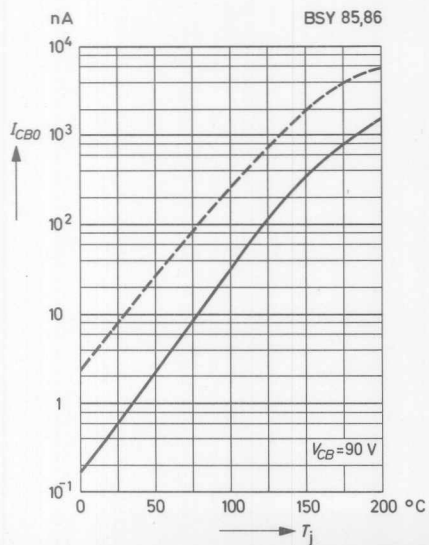
$R_{th A}$ < 194 °C/W
 $R_{th C}$ < 35 °C/W

BSY 85

Common emitter collector characteristics

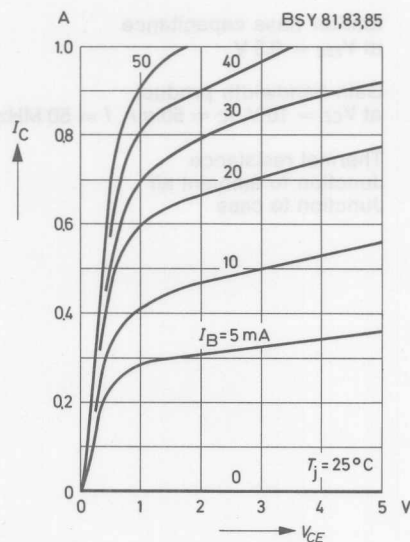


Collector cutoff current versus junction temperature

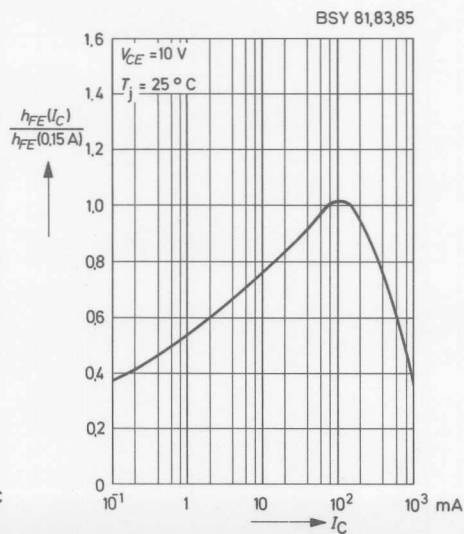


--- upper limit, valid for 95 % of a lot

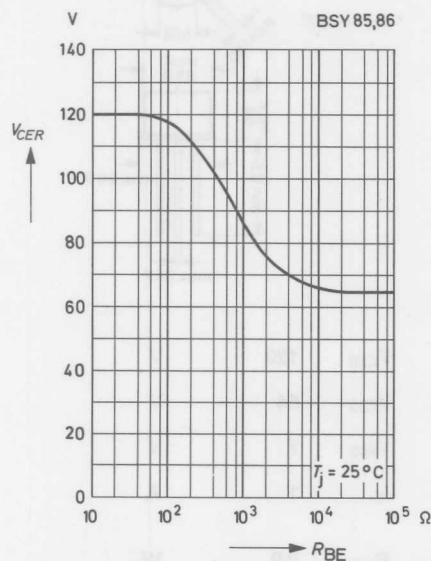
Common emitter collector characteristics



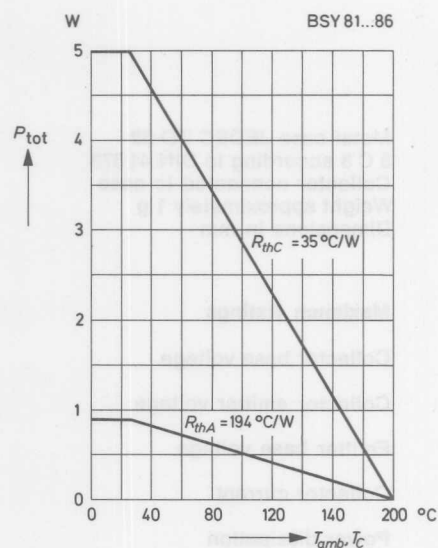
Relative DC current gain versus collector current



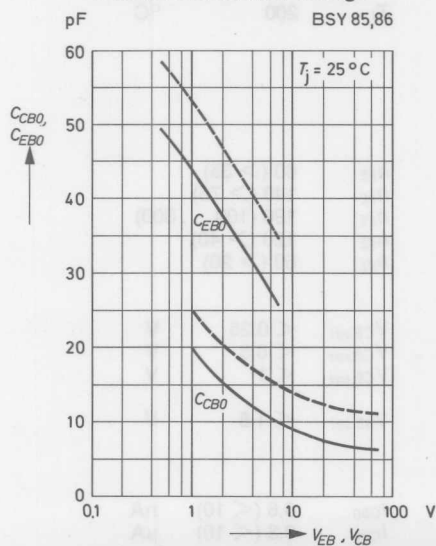
Admissible collector emitter
voltage versus
base emitter resistance



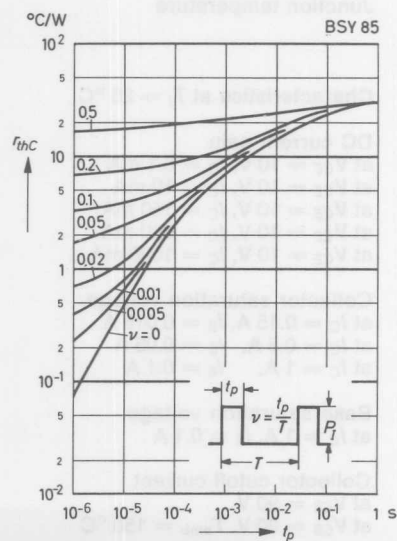
Admissible power dissipation
versus temperature



Collector base capacitance,
Emitter base capacitance
versus reverse bias voltage



Pulse thermal resistance
versus pulse duration

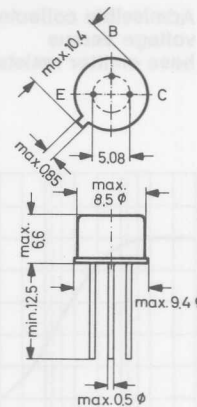


----- upper limit, valid for 95 % of a lot

BSY 86

NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications
at high collector current

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	120	V
Collector emitter voltage	V_{CE0}	64	V
Emitter base voltage	V_{EB0}	7	V
Collector current	I_C	1	A
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.9	W
at $T_C = 100^\circ\text{C}$	P_{tot}	2.8	W
at $T_C = 25^\circ\text{C}$	P_{tot}	5	W
Junction temperature	T_j	200	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$	h_{FE}	60 (> 35)
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$	h_{FE}	140 (> 75)
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$	h_{FE}	190 (100...300)
at $V_{CE} = 10\text{ V}$, $I_C = 500\text{ mA}$	h_{FE}	120 (> 40)
at $V_{CE} = 10\text{ V}$, $I_C = 1000\text{ mA}$	h_{FE}	50 (> 20)

Collector saturation voltage

at $I_C = 0.15\text{ A}$, $I_B = 0.015\text{ A}$	$V_{CE sat}$	< 0.25	V
at $I_C = 0.5\text{ A}$, $I_B = 0.05\text{ A}$	$V_{CE sat}$	< 0.6	V
at $I_C = 1\text{ A}$, $I_B = 0.1\text{ A}$	$V_{CE sat}$	< 1	V

Base saturation voltage

at $I_C = 1\text{ A}$, $I_B = 0.1\text{ A}$	$V_{BE sat}$	< 1.8	V
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Collector cutoff current

at $V_{CB} = 90\text{ V}$	I_{CB0}	0.6 (< 10)	nA
at $V_{CB} = 90\text{ V}$, $T_{amb} = 150^\circ\text{C}$	I_{CB0}	0.3 (< 10)	μA

Emitter cutoff current
at $V_{EB} = 3 \text{ V}$

I_{EBO} 5 (< 10) nA

Collector base capacitance
at $V_{CB0} = 10 \text{ V}$

C_{CB0} 8.5 (< 15) pF

Emitter base capacitance
at $V_{EB0} = 0.5 \text{ V}$

C_{EB0} 50 (< 60) pF

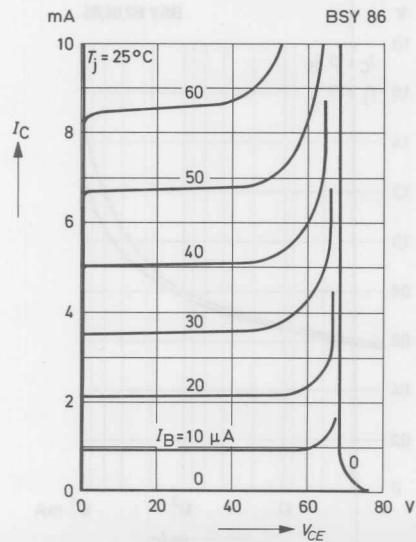
Gain bandwidth product
at $V_{CE} = 10 \text{ V}$, $I_C = 50 \text{ mA}$, $f = 50 \text{ MHz}$

f_T 130 MHz

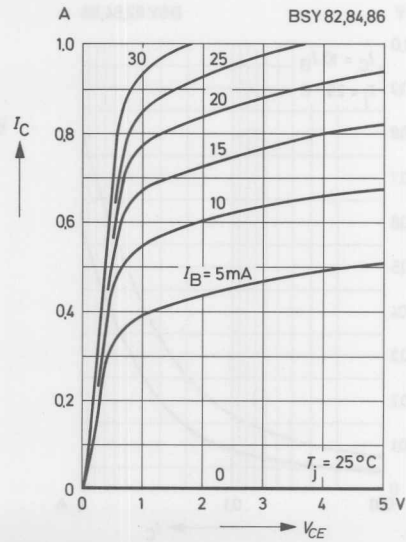
Thermal resistance
Junction to ambient air
Junction to case

R_{thA} < 194 °C/W
 R_{thC} < 35 °C/W

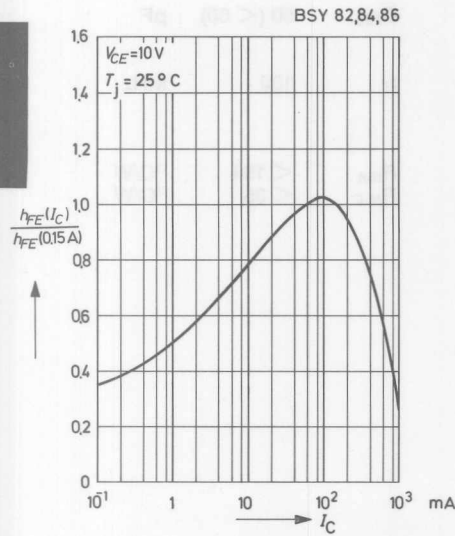
Common emitter
collector characteristics



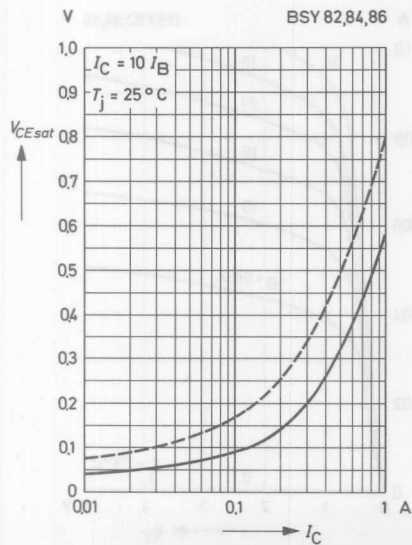
Common emitter
collector characteristics



Relative DC current gain
versus collector current

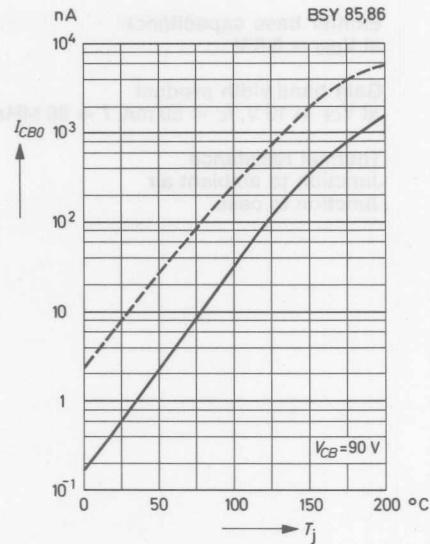


Collector saturation voltage
versus collector current

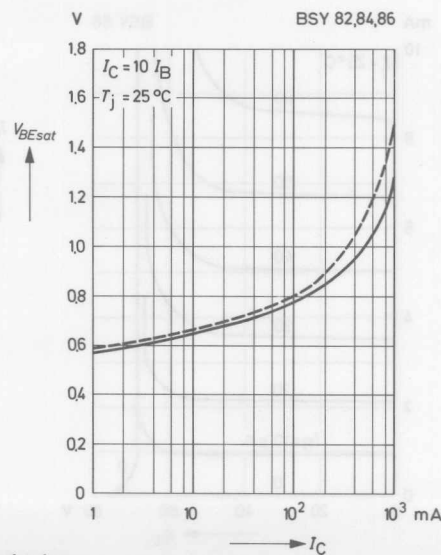


--- upper limit, valid for 95 % of a lot

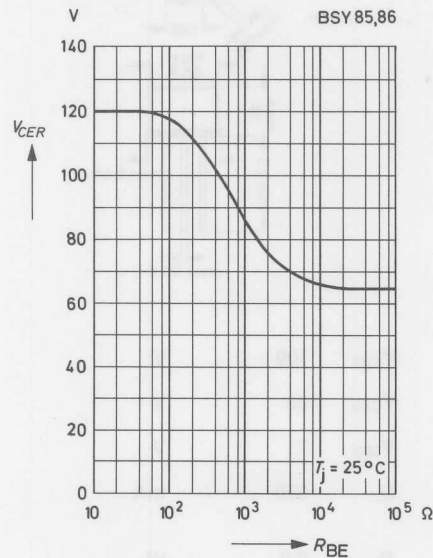
Collector cutoff current
versus junction temperature



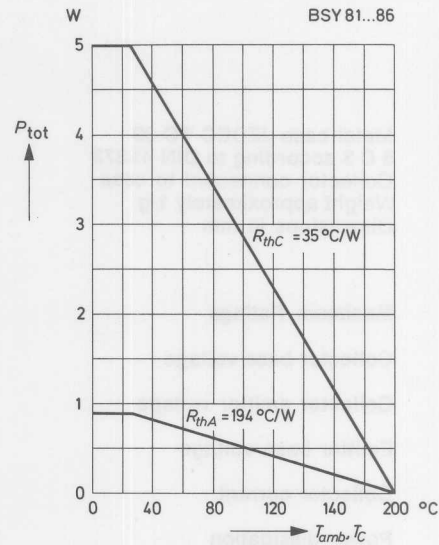
Base saturation voltage
versus collector current



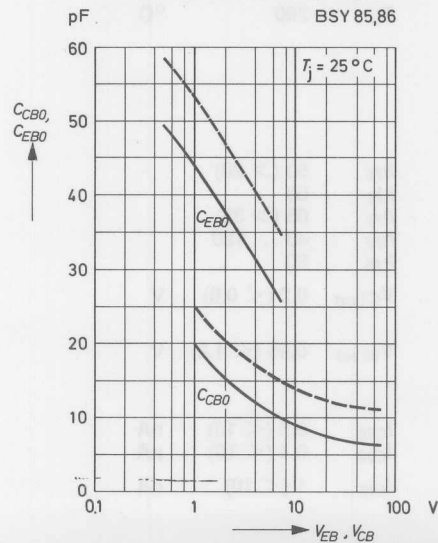
Admissible collector emitter voltage versus base emitter resistance



Admissible power dissipation versus temperature

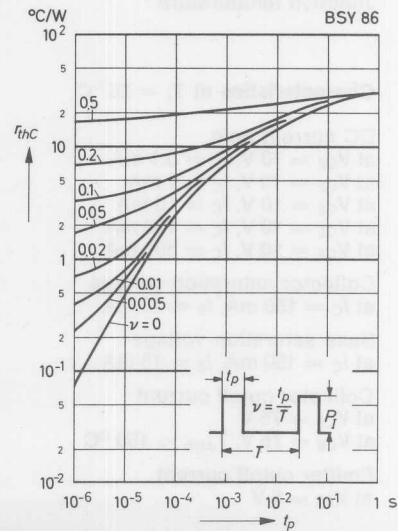


Collector base capacitance, Emitter base capacitance versus reverse bias voltage



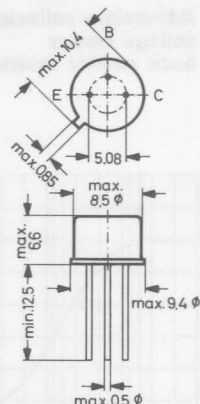
--- upper limit, valid for 95 % of a lot

Pulse thermal resistance versus pulse duration



NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	100	V
Collector emitter voltage	V_{CE0}	60	V
Emitter base voltage	V_{EB0}	7	V
Collector current	I_C	500	mA
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 100^\circ\text{C}$	P_{tot}	1.7	W
at $T_C = 25^\circ\text{C}$	P_{tot}	3	W
Junction temperature	T_j	200	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $V_{CE} = 10 \text{ V}$, $I_C = 0.1 \text{ mA}$

at $V_{CE} = 10 \text{ V}$, $I_C = 1 \text{ mA}$

at $V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$

at $V_{CE} = 10 \text{ V}$, $I_C = 150 \text{ mA}$

at $V_{CE} = 10 \text{ V}$, $I_C = 500 \text{ mA}$

Collector saturation voltage

at $I_C = 150 \text{ mA}$, $I_B = 15 \text{ mA}$

Base saturation voltage

at $I_C = 150 \text{ mA}$, $I_B = 15 \text{ mA}$

Collector cutoff current

at $V_{CB} = 75 \text{ V}$

at $V_{CB} = 75 \text{ V}$, $T_{amb} = 150^\circ\text{C}$

Emitter cutoff current

at $V_{EB} = 5 \text{ V}$

h_{FE}	50 (> 20)	
h_{FE}	60	
h_{FE}	65 (> 35)	
h_{FE}	40 ... 120	
h_{FE}	20	
$V_{CE\ sat}$	0.2 (< 0.6)	V
$V_{BE\ sat}$	0.95 (< 1.2)	V
I_{CBO}	0.5 (< 10)	nA
I_{CBO}	0.4 (< 10)	μ A
I_{EBO}	1 (< 10)	nA

Collector base capacitance at $V_{CB0} = 10\text{ V}$	C_{CB0}	5.5 (< 10)	pF
Emitter base capacitance at $V_{EB0} = 0.5\text{ V}$	C_{EB0}	23 (< 33)	pF
Thermal resistance Junction to ambient air	R_{thA}	< 220	$^{\circ}\text{C/W}$
Junction to case	R_{thC}	< 58	$^{\circ}\text{C/W}$

Small Signal Characteristics at $T_{amb} = 25\text{ }^{\circ}\text{C}$ and $f = 1\text{ kHz}$

Test conditions: $V_{CE} = 5\text{ V}$, $I_C = 1\text{ mA}$, grounded emitter

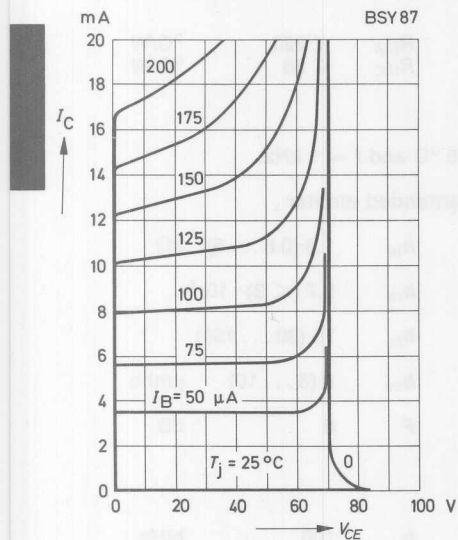
Input impedance	h_{ie}	1.8 (0.8 ... 5)	k Ω
Reverse voltage transfer ratio	h_{re}	$0.7 (< 3) \cdot 10^{-4}$	
Small signal current gain	h_{fe}	75 (30 ... 150)	
Output admittance	h_{oe}	6 (3 ... 10)	μmho
Noise figure at $V_{CE} = 10\text{ V}$, $I_C = 0.3\text{ mA}$, $R_G = 1.5\text{ k}\Omega$, Bandwidth 30 Hz ... 15 kHz	F	6	dB
Gain bandwidth product at $V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$, $f = 50\text{ MHz}$	f_T	100	MHz

Switching Times

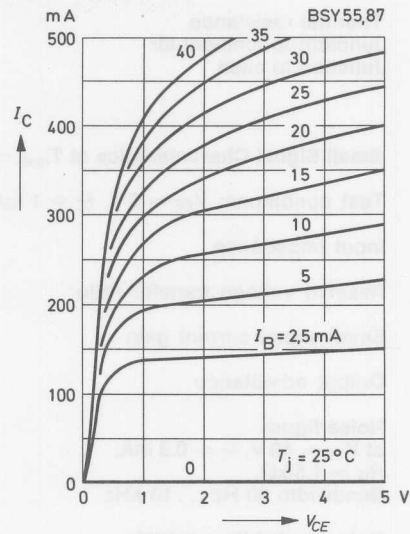
Specifications for switching times of type BSY 51 apply to this type.

BSY 87

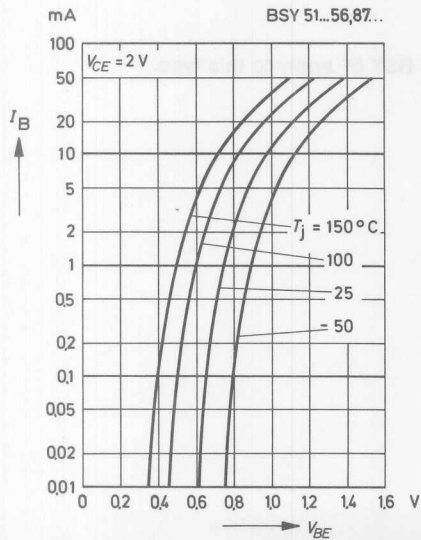
Common emitter
collector characteristics



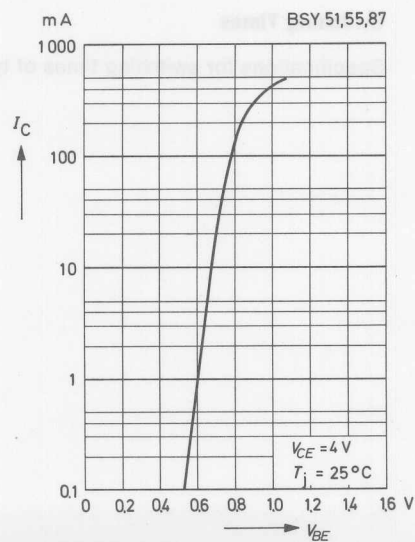
Common emitter
collector characteristics



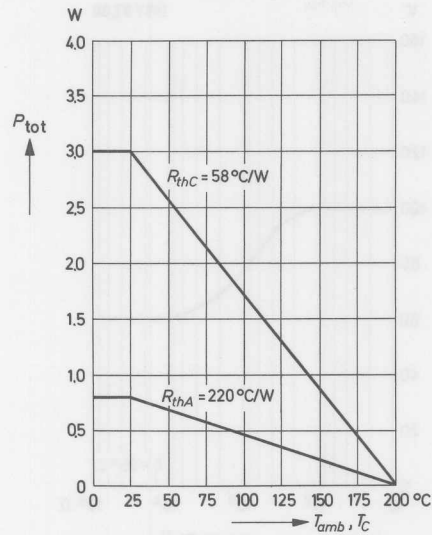
Common emitter
input characteristics



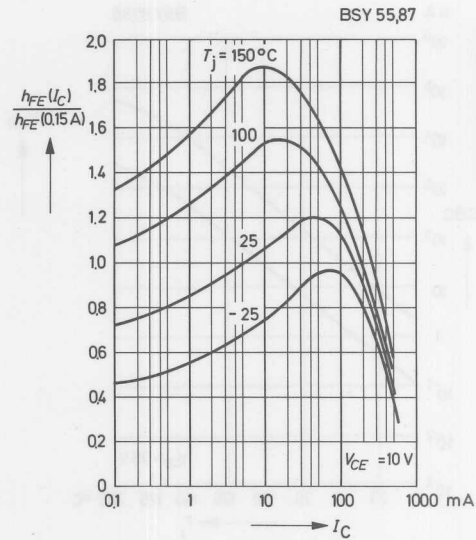
Collector current versus
base emitter voltage



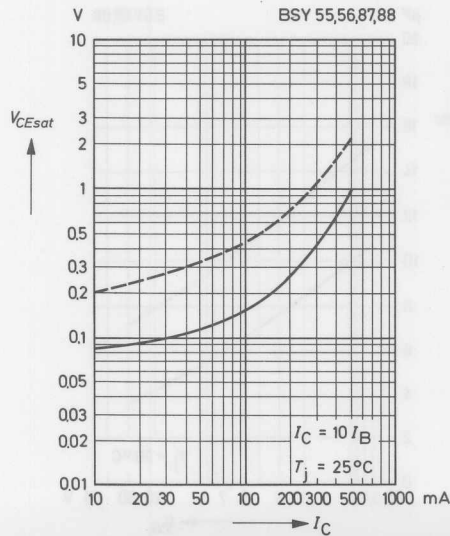
**Admissible power dissipation
versus temperature**



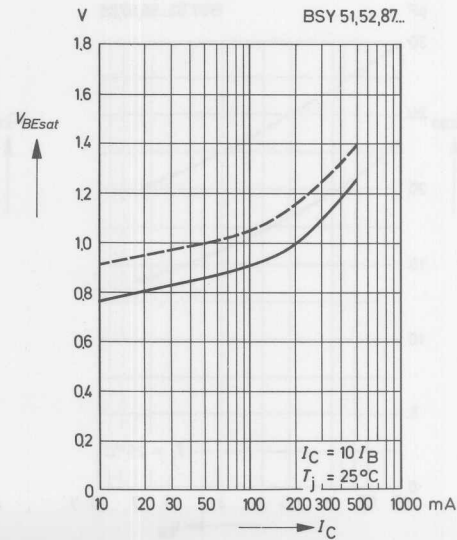
**Relative DC current gain
versus collector current**



**Collector saturation voltage
versus collector current**



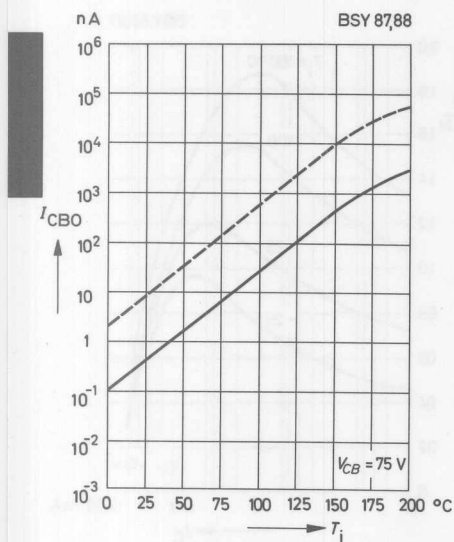
**Base saturation voltage
versus collector current**



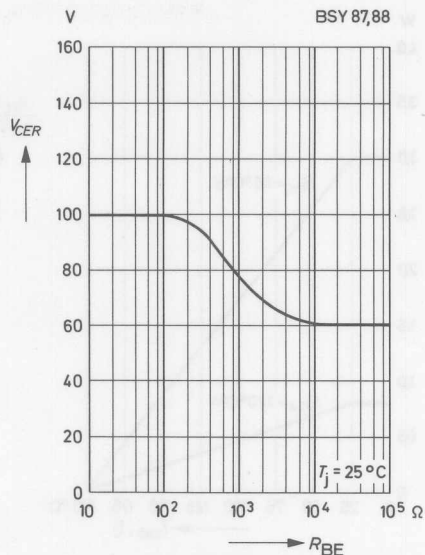
--- upper limit, valid for 95 % of a lot

BSY 87

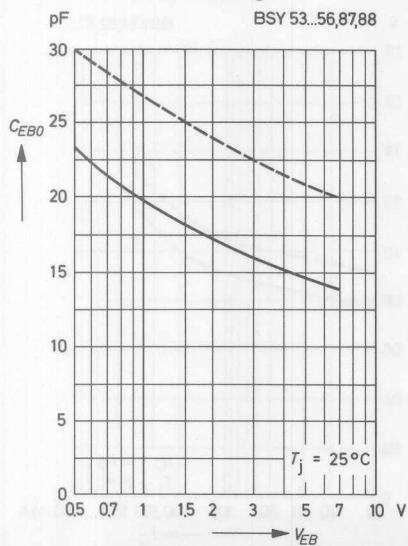
**Collector cutoff current
versus
junction temperature**



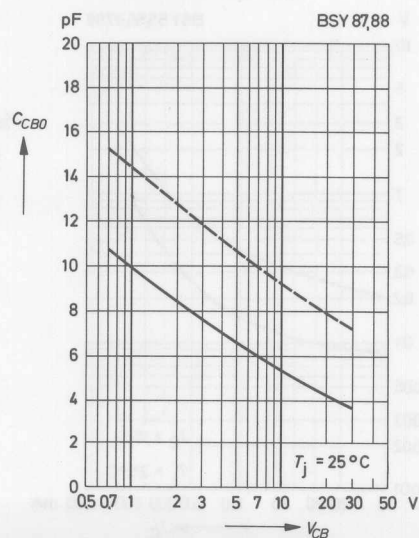
**Admissible collector emitter
voltage versus
base emitter resistance**



**Emitter base capacitance
versus
emitter base voltage**

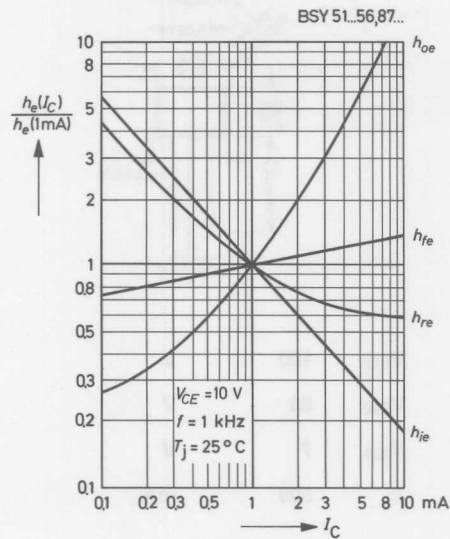


**Collector base capacitance
versus
collector base voltage**

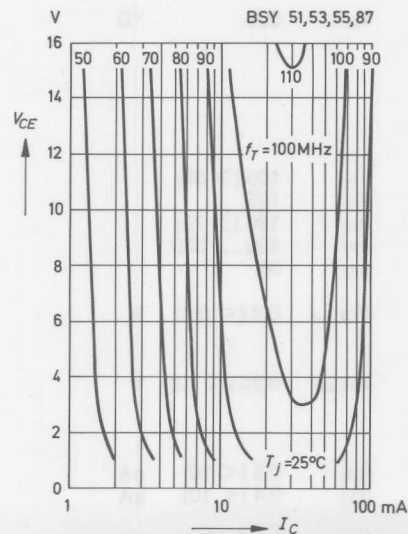


--- upper limit, valid for 95 % of a lot

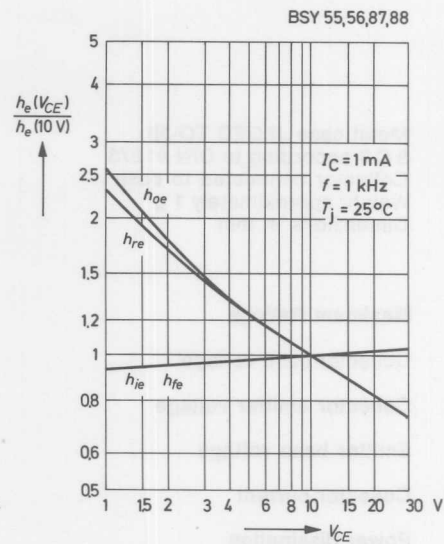
Relative h -parameters
versus
collector current



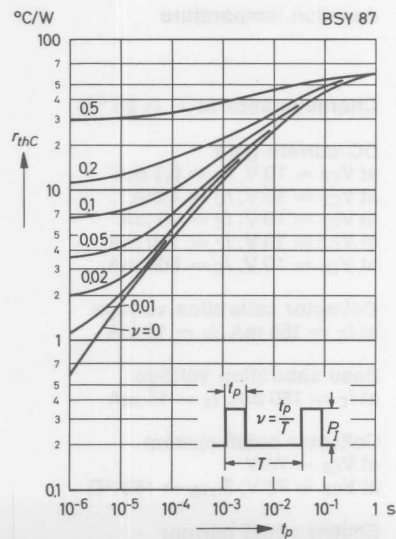
Contours of constant
gain bandwidth product



Relative h -parameters
versus
collector emitter voltage

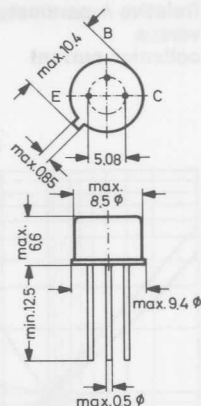


Pulse thermal resistance
versus pulse duration



NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm


Maximum Ratings

Collector base voltage	V_{CB0}	100	V
Collector emitter voltage	V_{CE0}	60	V
Emitter base voltage	V_{EB0}	7	V
Collector current	I_C	500	mA
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 100^\circ\text{C}$	P_{tot}	1.7	W
at $T_C = 25^\circ\text{C}$	P_{tot}	3	W
Junction temperature	T_j	200	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$
DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$	h_{FE}	100 (> 35)
at $V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$	h_{FE}	125
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$	h_{FE}	180 (> 75)
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$	h_{FE}	100 ... 300
at $V_{CE} = 10\text{ V}$, $I_C = 500\text{ mA}$	h_{FE}	35

Collector saturation voltage
at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$

$V_{CE\text{ sat}}$	0.2 (< 0.6)	V
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Base saturation voltage
at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$

$V_{BE\text{ sat}}$	0.95 (< 1.2)	V
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Collector cutoff current

at $V_{CB} = 75\text{ V}$
at $V_{CB} = 75\text{ V}$, $T_{amb} = 150^\circ\text{C}$

I_{CB0}	0.5 (< 10)	nA
I_{CB0}	0.4 (< 10)	μA

Emitter cutoff current
at $V_{EB} = 5\text{ V}$

I_{EB0}	1 (< 10)	nA
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Collector base capacitance at $V_{CB0} = 10\text{ V}$	C_{CB0}	5.5 (< 10)	pF
Emitter base capacitance at $V_{EB0} = 0.5\text{ V}$	C_{EB0}	23 (< 33)	pF
Thermal resistance Junction to ambient air	R_{thA}	< 220	$^{\circ}\text{C/W}$
Junction to case	R_{thC}	< 58	$^{\circ}\text{C/W}$

Small Signal Characteristics at $T_{amb} = 25\text{ }^{\circ}\text{C}$ and $f = 1\text{ kHz}$

Test conditions: $V_{CE} = 5\text{ V}$, $I_C = 1\text{ mA}$, grounded emitter

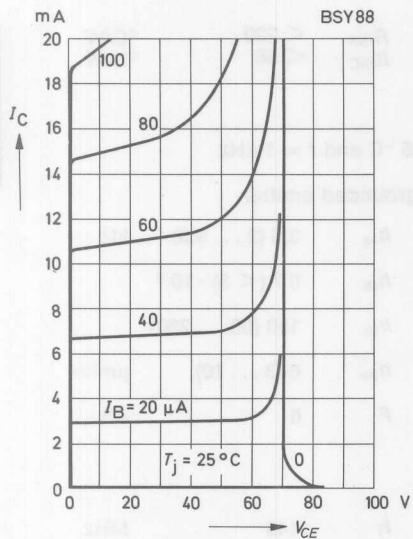
Input impedance	h_{ie}	3.5 (2 ... 9.5)	$\text{k}\Omega$
Reverse voltage transfer ratio	h_{re}	$0.7 (< 3) \cdot 10^{-4}$	
Small signal current gain	h_{fe}	150 (60 ... 280)	
Output admittance	h_{oe}	6 (3 ... 10)	μmho
Noise figure at $V_{CE} = 10\text{ V}$, $I_C = 0.3\text{ mA}$, $R_G = 1.5\text{ k}\Omega$, Bandwidth 30 Hz ... 15 kHz	F	6	dB
Gain bandwidth product at $V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$, $f = 50\text{ MHz}$	f_T	145	MHz

Switching Times

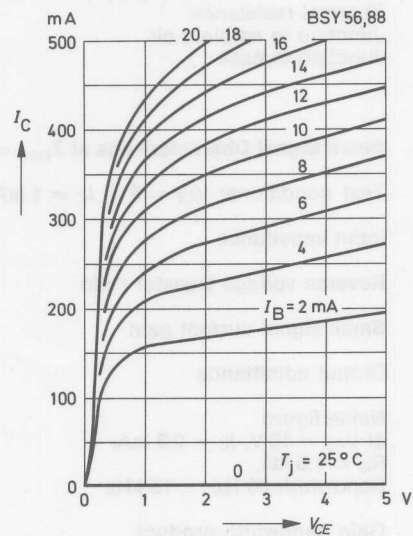
Specifications for switching times of type BSY 51 apply to this type.

BSY 88

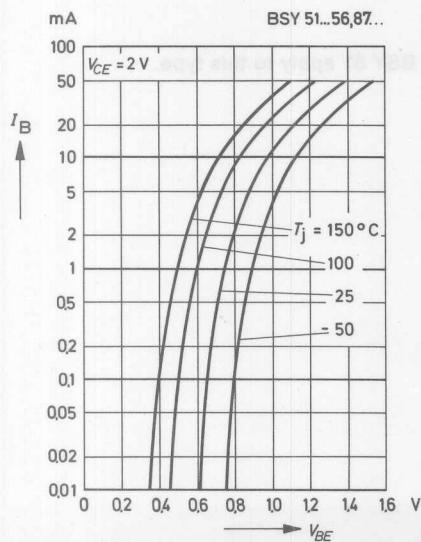
Common emitter
collector characteristics



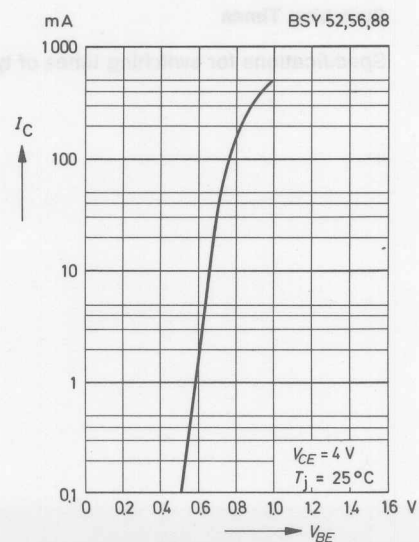
Common emitter
collector characteristics



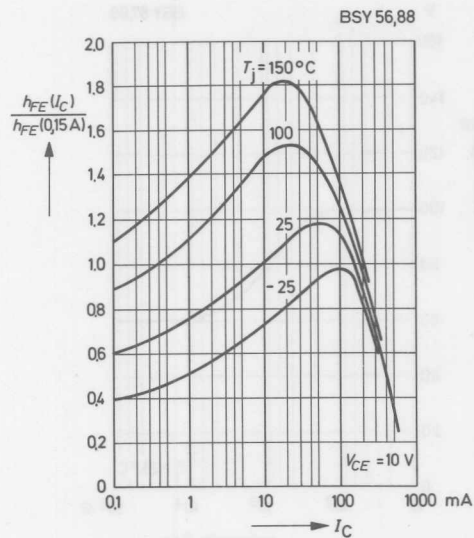
Common emitter
input characteristics



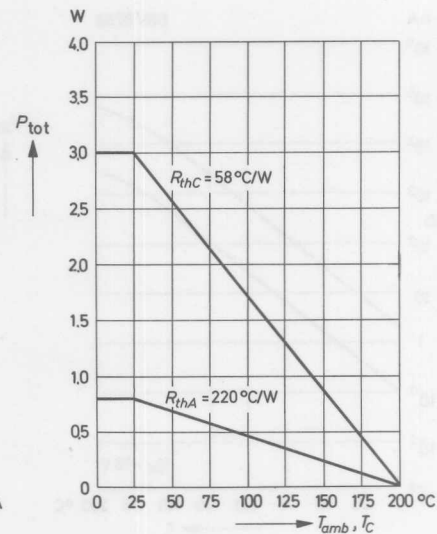
Collector current versus
base emitter voltage



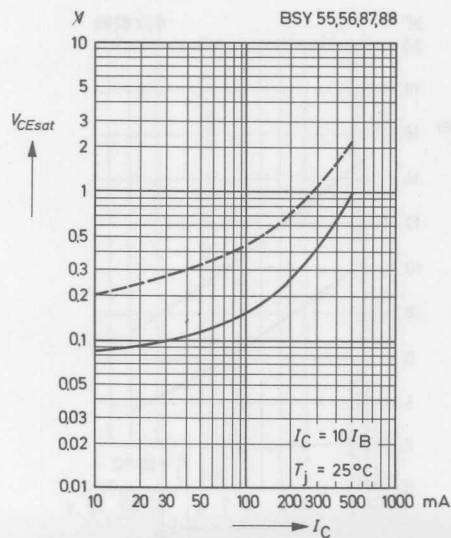
Relative DC current gain
versus collector current



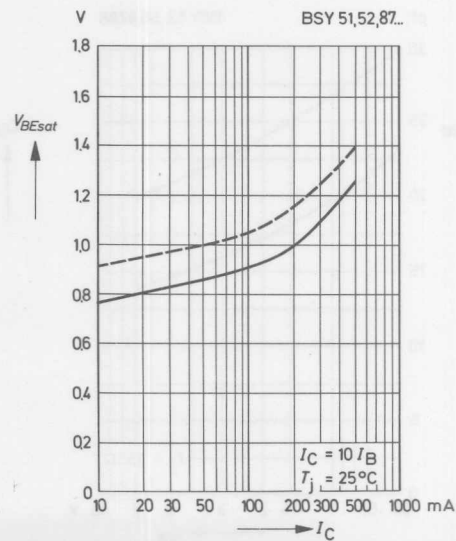
Admissible power dissipation
versus temperature



Collector saturation voltage
versus collector current

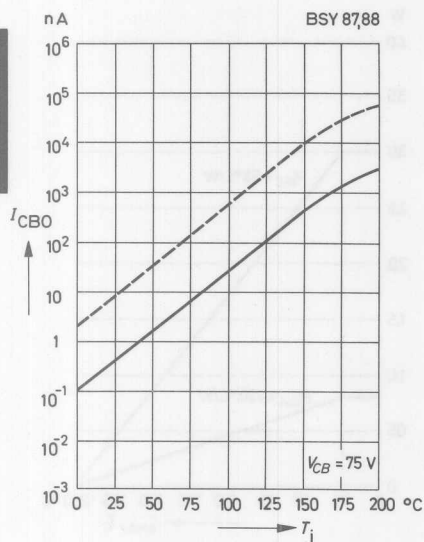


Base saturation voltage
versus collector current

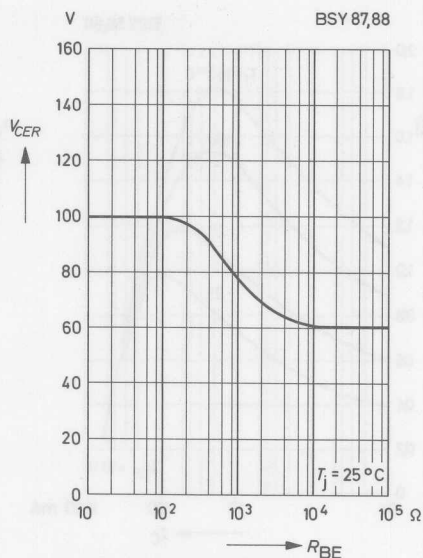


BSY 88

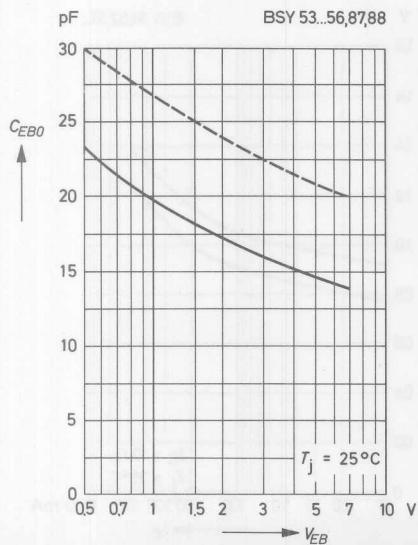
**Collector cutoff current
versus
junction temperature**



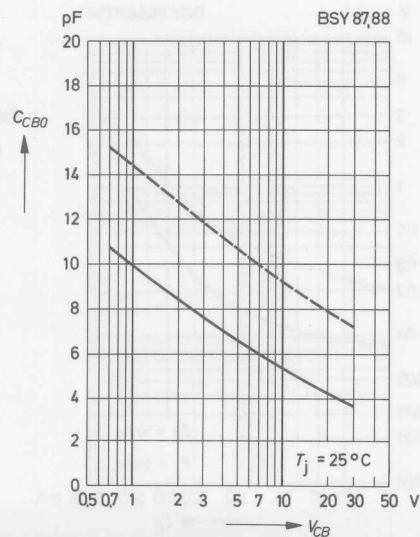
**Admissible collector emitter
voltage versus
base emitter resistor**



**Emitter base capacitance
versus emitter base voltage**

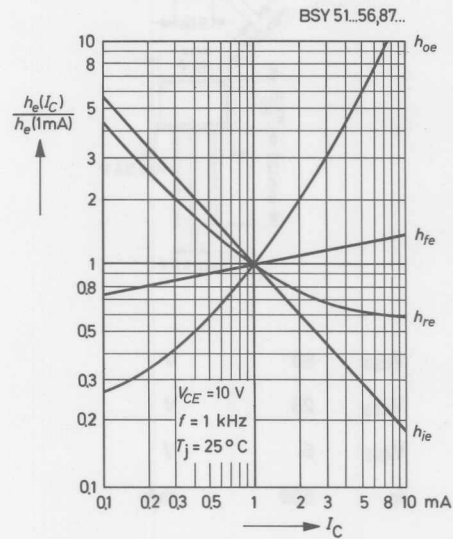


**Collector base capacitance
versus collector base voltage**

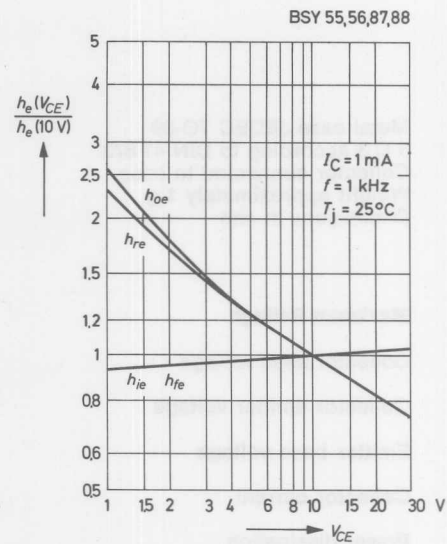


--- upper limit, valid for 95 % of a lot

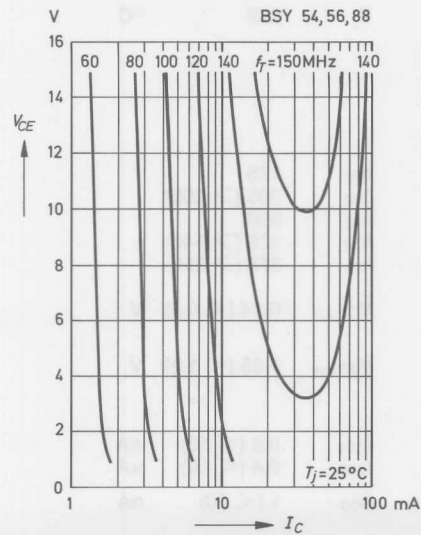
Relative h -parameters
versus
collector current



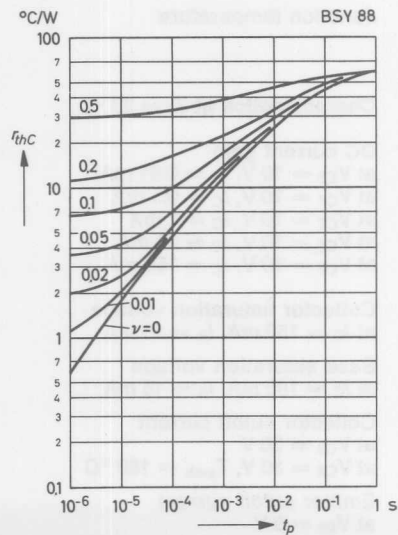
Relative h -parameters
versus
collector emitter voltage



Contours of constant
gain bandwidth product



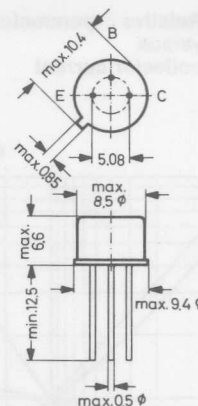
Pulse thermal resistance
versus pulse duration



BSY 90

NPN Silicon Epitaxial Transistor
for switching and amplifier applications

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	60	V
Collector emitter voltage	V_{CE0}	25	V
Emitter base voltage	V_{EB0}	5	V
Collector current	I_C	500	mA
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 100^\circ\text{C}$	P_{tot}	1.7	W
at $T_C = 25^\circ\text{C}$	P_{tot}	3	W
Junction temperature	T_j	200	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 0.01\text{ mA}$
at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$
at $V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$

h_{FE}	125
h_{FE}	200 (> 100)
h_{FE}	300
h_{FE}	425 (> 140)
h_{FE}	375 (> 250)

Collector saturation voltage
at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$

$V_{CE\text{ sat}}$	0.14 (< 0.8)	V
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Base saturation voltage
at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$

$V_{BE\text{ sat}}$	0.95 (< 1.2)	V
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Collector cutoff current

at $V_{CB} = 30\text{ V}$
at $V_{CB} = 30\text{ V}$, $T_{amb} = 150^\circ\text{C}$

I_{CB0}	0.5 (< 10)	nA
I_{CB0}	0.4 (< 10)	μA

Emitter cutoff current
at $V_{EB} = 3\text{ V}$

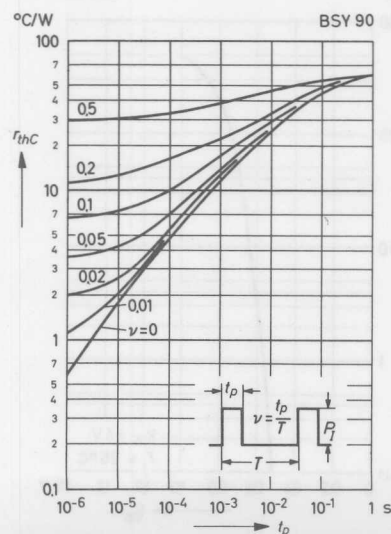
I_{EB0}	1 (< 50)	nA
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Collector base capacitance at $V_{CB0} = 10\text{ V}$	C_{CB0}	7.5 (< 10)	pF
Emitter base capacitance at $V_{EB0} = 0.5\text{ V}$	C_{EB0}	23 (< 33)	pF
Thermal resistance Junction to ambient air	R_{thA}	< 220	°C/W
Junction to case	R_{thC}	< 58	°C/W

Small Signal Characteristics at $T_{amb} = 25\text{ °C}$ and $f = 1\text{ kHz}$

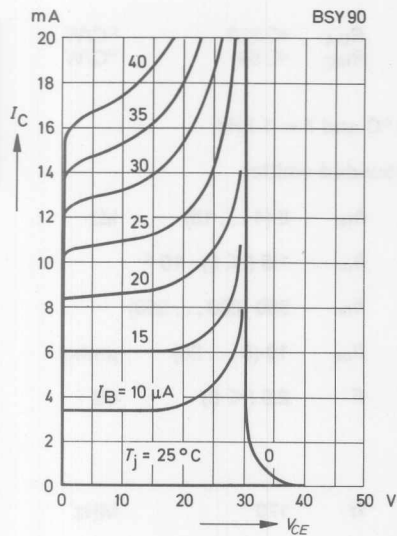
 Test conditions: $V_{CE} = 5\text{ V}$, $I_C = 1\text{ mA}$, grounded emitter

Input impedance	h_{ie}	8 (4 ... 15)	k Ω
Reverse voltage transfer ratio	h_{re}	$1.5 (< 5) \cdot 10^{-4}$	
Small signal current gain	h_{fe}	350 (200 ... 550)	
Output admittance	h_{oe}	10 (5 ... 25)	μmho
Noise figure at $V_{CE} = 10\text{ V}$, $I_C = 0.3\text{ mA}$, $R_G = 1.5\text{ k}\Omega$, Bandwidth 30 Hz ... 15 kHz	F	2.5 (< 8)	dB
Gain bandwidth product at $V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$, $f = 50\text{ MHz}$	f_T	170	MHz

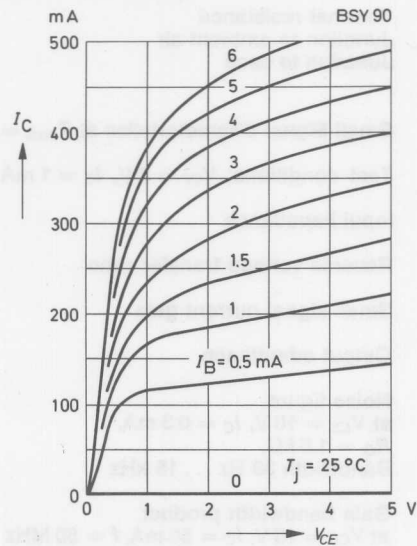
**Pulse thermal resistance
versus pulse duration**


BSY 90

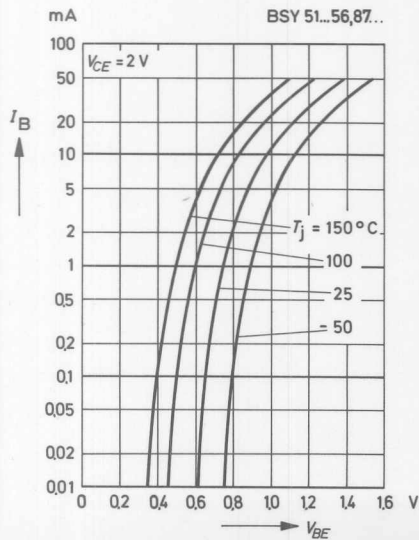
**Common emitter
collector characteristics**



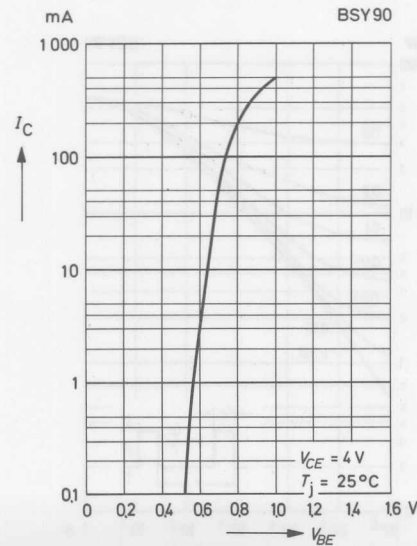
**Common emitter
collector characteristics**



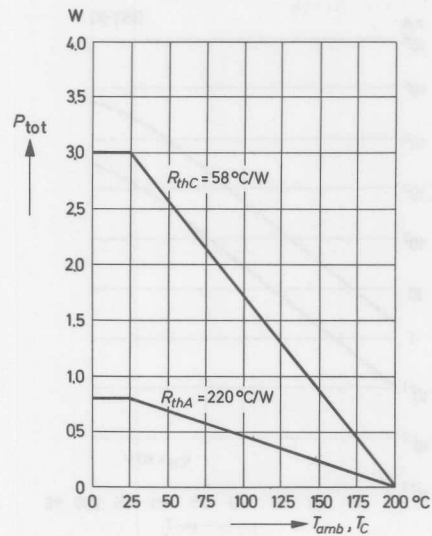
**Common emitter
input characteristics**



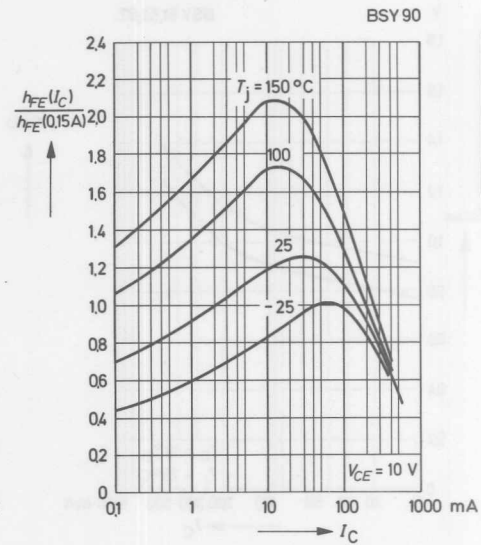
**Collector current versus
base emitter voltage**



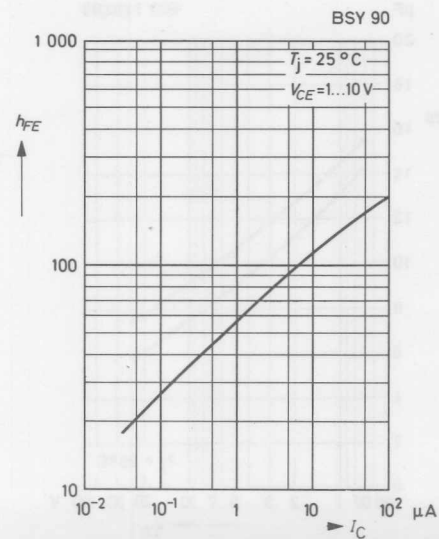
**Admissible power dissipation
versus temperature**



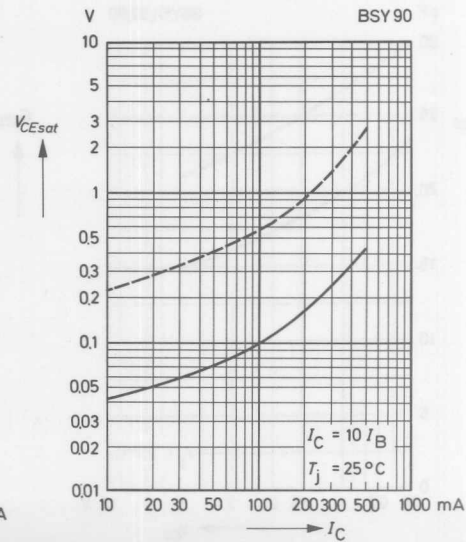
**Relative DC current gain
versus collector current**



**DC current gain versus
small collector current**



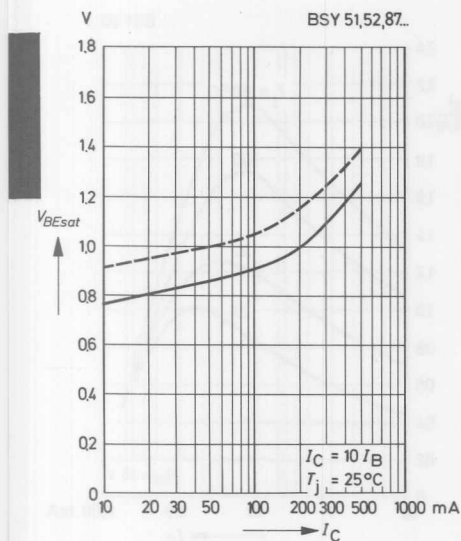
**Collector saturation voltage
versus collector current**



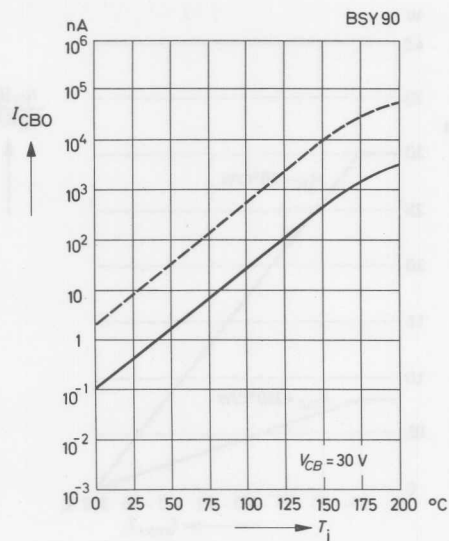
--- upper limit, valid for 95 % of a lot

BSY 90

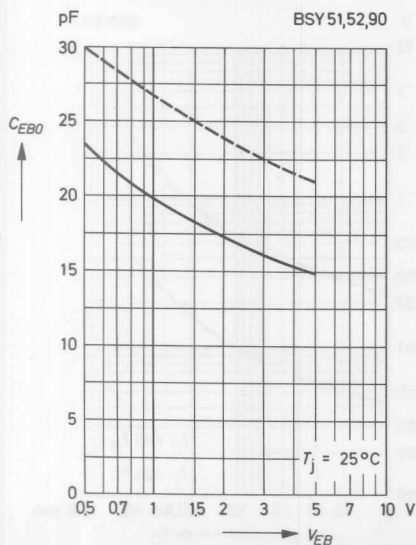
**Base saturation voltage
versus collector current**



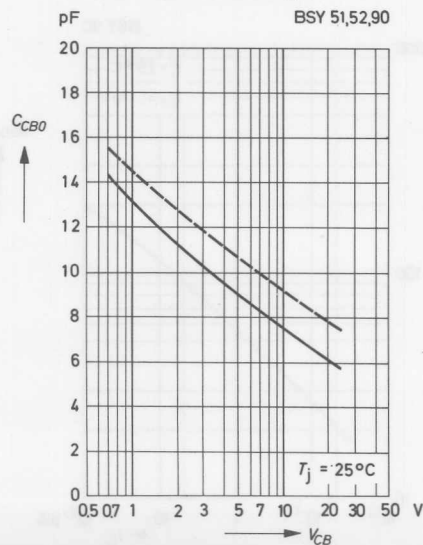
**Collector cutoff current
versus junction temperature**



**Emitter base capacitance
versus
emitter base voltage**

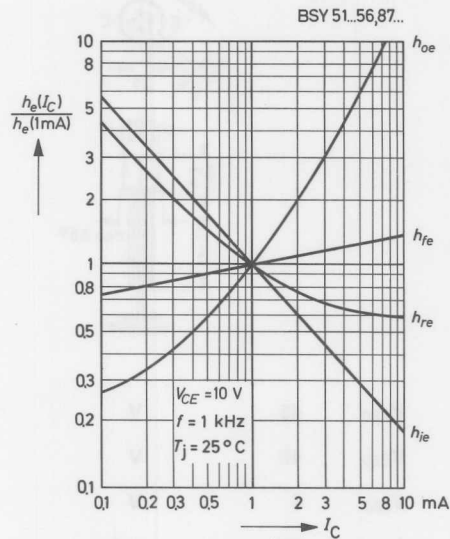


**Collector base capacitance
versus
collector base voltage**

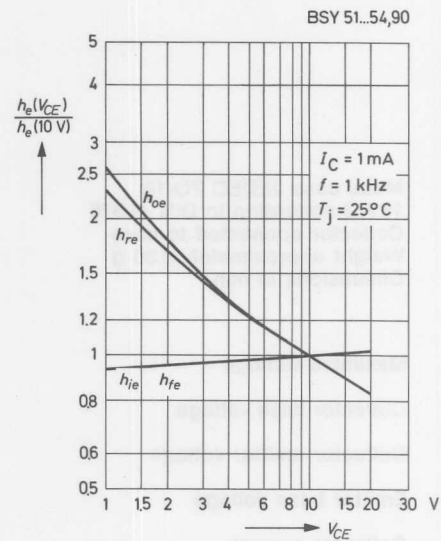


--- upper limit, valid for 95 % of a lot

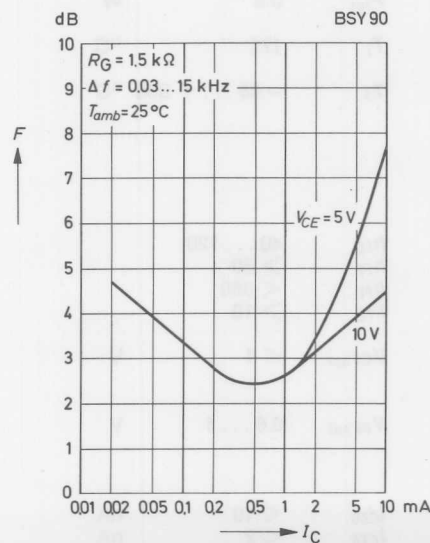
Relative h -parameters
versus
collector current



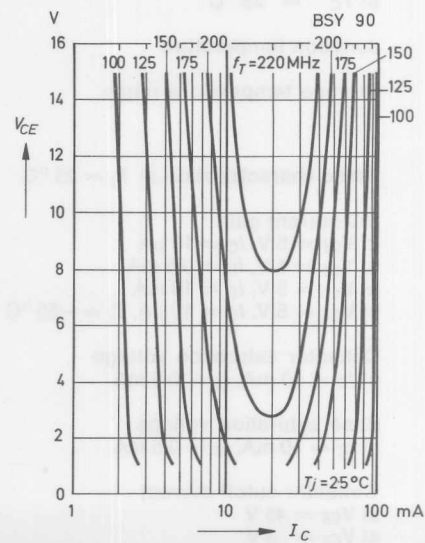
Relative h -parameters
versus
collector emitter voltage



Noise figure versus
collector current



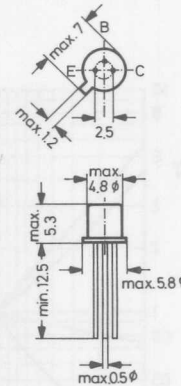
Contours of constant
gain bandwidth product



NPN Silicon Planar Transistor

for use in high-performance, low-level, low-noise amplifier
circuits from audio through high frequency ranges

Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

**Maximum Ratings**

Collector base voltage	V_{CB0}	45	V
Collector emitter voltage	V_{CE0}	45	V
Emitter base voltage	V_{EB0}	5	V
Collector current	I_C	30	mA
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.3	W
at $T_C = 25^\circ\text{C}$	P_{tot}	0.6	W
Junction temperature	T_j	175	$^\circ\text{C}$
Storage temperature range	T_S	$-65 \dots +300^\circ\text{C}$	

Static characteristics at $T_j = 25^\circ\text{C}$ **DC current gain**

at $V_{CE} = 5\text{ V}$, $I_C = 10\text{ }\mu\text{A}$
 at $V_{CE} = 5\text{ V}$, $I_C = 0.5\text{ mA}$
 at $V_{CE} = 5\text{ V}$, $I_C = 10\text{ mA}$
 at $V_{CE} = 5\text{ V}$, $I_C = 10\text{ }\mu\text{A}$, $T_j = -55^\circ\text{C}$

h_{FE}	40 ... 120
h_{FE}	> 60
h_{FE}	< 350
h_{FE}	> 10

Collector saturation voltage
at $I_C = 10\text{ mA}$, $I_B = 0.5\text{ mA}$

$V_{CE\text{ sat}}$	< 1	V
---------------------	-----	---

Base saturation voltage
at $I_C = 10\text{ mA}$, $I_B = 0.5\text{ mA}$

$V_{BE\text{ sat}}$	0.6 ... 1	V
---------------------	-----------	---

Collector cutoff current

at $V_{CB} = 45\text{ V}$
 at $V_{CE} = 5\text{ V}$
 at $V_{CE} = 45\text{ V}$, $V_{BE} = 0$

I_{CB0}	< 10	nA
I_{CE0}	< 2	nA
I_{CES}	< 10	nA

Emitter cutoff current
at $V_{EB} = 5 \text{ V}$

$I_{EB0} < 10 \text{ nA}$

Thermal resistance
Junction to ambient air
Junction to case

$R_{thA} < 500 \text{ }^{\circ}\text{C/W}$
 $R_{thC} < 250 \text{ }^{\circ}\text{C/W}$

Dynamic characteristics at $T_{amb} = 25 \text{ }^{\circ}\text{C}$

Collector base capacitance
at $V_{CB} = 5 \text{ V}, f = 1 \text{ MHz}$

$C_{CB0} < 8 \text{ pF}$

Gain bandwidth product
at $V_{CE} = 5 \text{ V}, I_C = 0.5 \text{ mA}$

$f_T > 30 \text{ MHz}$

h-parameters, grounded base

Test conditions: $V_{CB} = 5 \text{ V}, -I_E = 1 \text{ mA}, f = 1 \text{ kHz}$

Input impedance

$h_{ib} 25 \dots 32 \text{ } \Omega$

Reverse voltage transfer ratio

$h_{rb} < 6 \cdot 10^{-4}$

Output admittance

$h_{ob} < 1 \text{ } \mu\text{mho}$

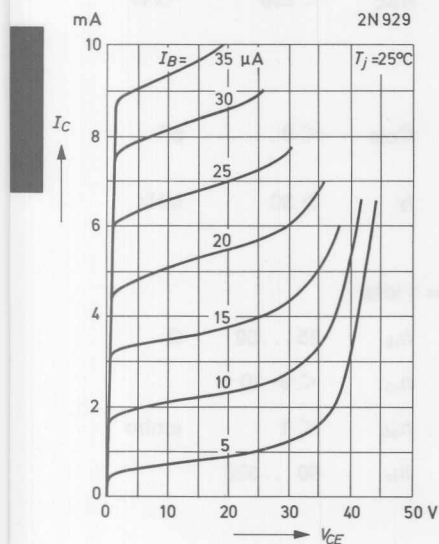
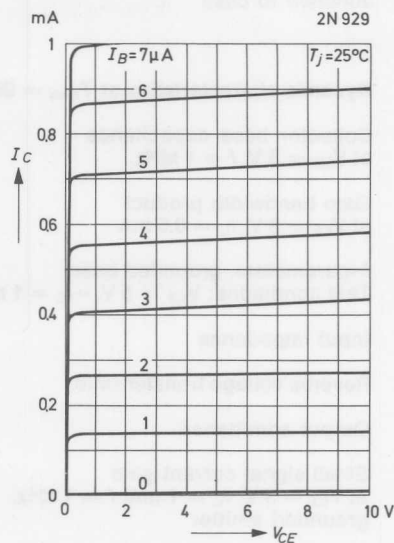
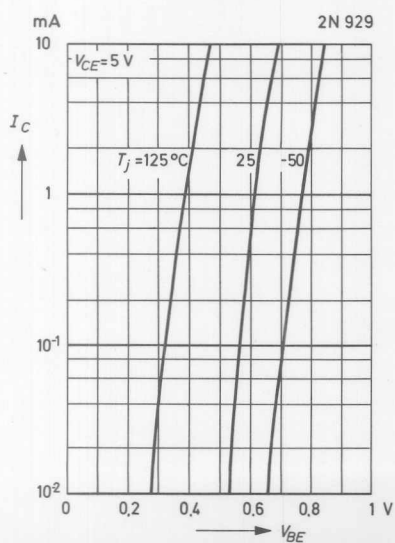
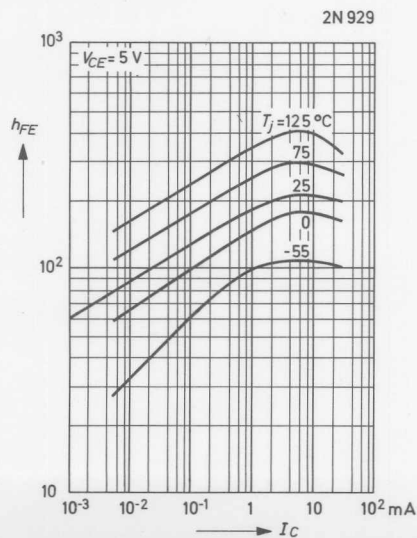
Small signal current gain
at $V_{CE} = 5 \text{ V}, I_C = 1 \text{ mA}, f = 1 \text{ kHz}$,
grounded emitter

$h_{ie} 60 \dots 350$

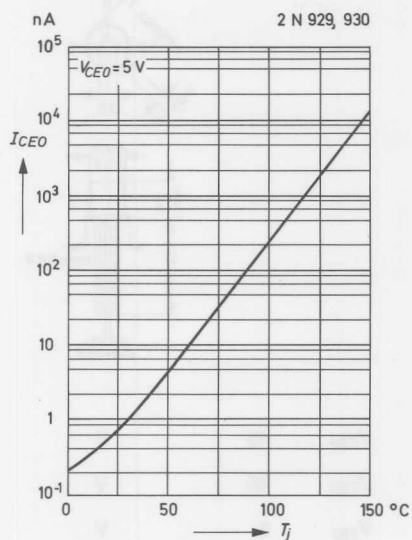
Noise figure

at $V_{CE} = 5 \text{ V}, I_C = 10 \text{ } \mu\text{A}$,
 $R_G = 10 \text{ k}\Omega, f = 10 \text{ Hz} \dots 15 \text{ kHz}$

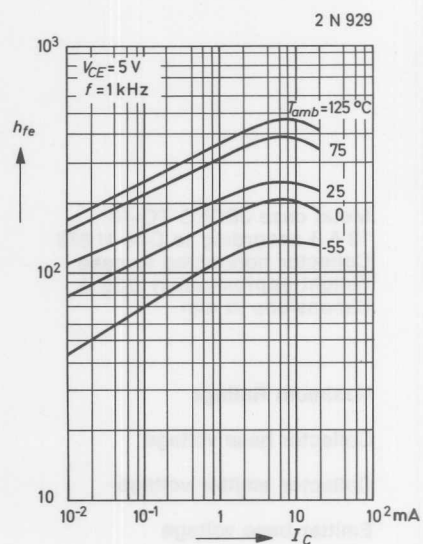
$F < 4 \text{ dB}$

Common emitter
collector characteristics

Common emitter
collector characteristics

Collector current versus
base emitter voltage

DC current gain
versus collector current


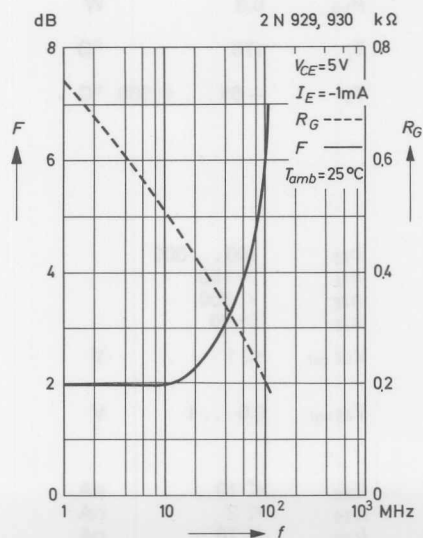
Collector cutoff current
versus junction temperature



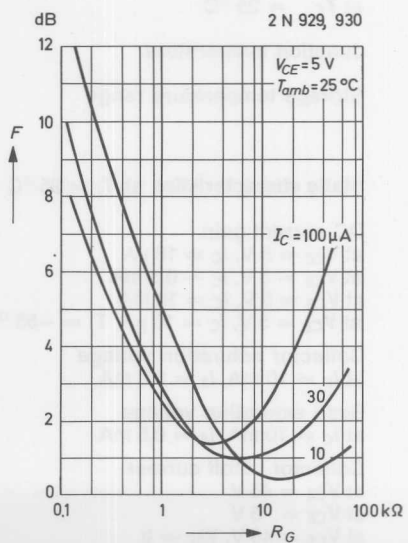
Small signal current gain
versus collector current



Noise figure
versus frequency



Noise figure versus
generator resistance

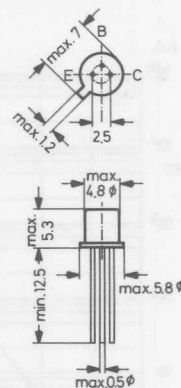


2 N 930

NPN Silicon Planar Transistor

for use in high-performance, low-level, low-noise amplifier circuits from audio through high frequency ranges

Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	45	V
Collector emitter voltage	V_{CE0}	45	V
Emitter base voltage	V_{EB0}	5	V
Collector current	I_C	30	mA
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.3	W
at $T_C = 25^\circ\text{C}$	P_{tot}	0.6	W
Junction temperature	T_j	175	$^\circ\text{C}$
Storage temperature range	T_S	- 65 ... + 300	$^\circ\text{C}$

Static characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $V_{CE} = 5\text{ V}$, $I_C = 10\text{ }\mu\text{A}$
at $V_{CE} = 5\text{ V}$, $I_C = 0.5\text{ mA}$
at $V_{CE} = 5\text{ V}$, $I_C = 10\text{ mA}$
at $V_{CE} = 5\text{ V}$, $I_C = 10\text{ }\mu\text{A}$, $T_j = -55^\circ\text{C}$

h_{FE}	100 ... 300
h_{FE}	> 150
h_{FE}	< 600
h_{FE}	> 20

Collector saturation voltage
at $I_C = 10\text{ mA}$, $I_B = 0.5\text{ mA}$

$V_{CE\text{ sat}}$	< 1	V
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Base saturation voltage
at $I_C = 10\text{ mA}$, $I_B = 0.5\text{ mA}$

$V_{BE\text{ sat}}$	0.6 ... 1	V
---------------------	-----------	---

Collector cutoff current

at $V_{CB} = 45\text{ V}$
at $V_{CE} = 5\text{ V}$
at $V_{CE} = 45\text{ V}$, $V_{BE} = 0$

I_{CB0}	< 10	nA
I_{CE0}	< 2	nA
I_{CES}	< 10	nA

Emitter cutoff current
at $V_{EB} = 5 \text{ V}$

I_{EB0} < 10 nA

Thermal resistance
Junction to ambient air
Junction to case

R_{thA} < 500 °C/W
 R_{thC} < 250 °C/W

Dynamic characteristics at $T_{amb} = 25 \text{ °C}$

Collector base capacitance
at $V_{CB} = 5 \text{ V}$, $f = 1 \text{ MHz}$

C_{CB0} < 8 pF

Gain bandwidth product
at $V_{CE} = 5 \text{ V}$, $I_C = 0.5 \text{ mA}$

f_T > 30 MHz

h -parameters, grounded base

Test conditions: $V_{CB} = 5 \text{ V}$, $-I_E = 1 \text{ mA}$, $f = 1 \text{ kHz}$

Input impedance

h_{ib} $25 \dots 32$ Ω

Reverse voltage transfer ratio

h_{rb} $< 6 \cdot 10^{-4}$

Output admittance

h_{ob} < 1 μmho

Small signal current gain
at $V_{CE} = 5 \text{ V}$, $I_C = 1 \text{ mA}$, $f = 1 \text{ kHz}$,
grounded emitter

h_{fe} $150 \dots 600$

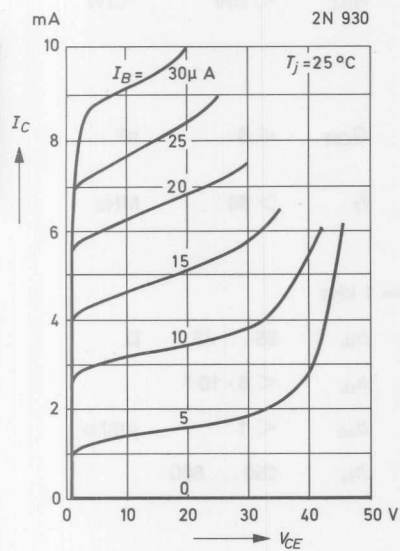
Noise figure

at $V_{CE} = 5 \text{ V}$, $I_C = 10 \text{ }\mu\text{A}$,
 $R_G = 10 \text{ k}\Omega$, $f = 10 \text{ Hz} \dots 15 \text{ kHz}$

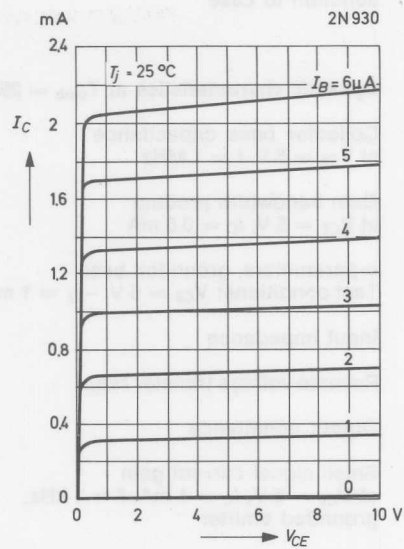
F < 3 dB

2N 930

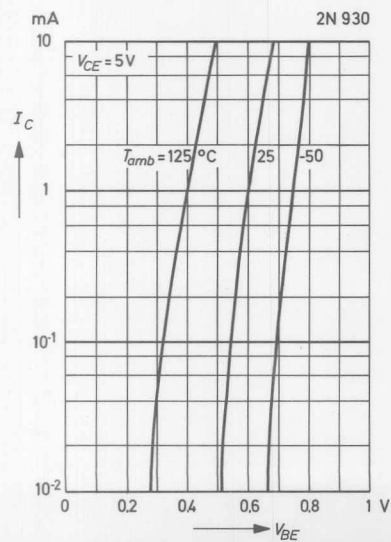
**Common emitter
collector characteristics**



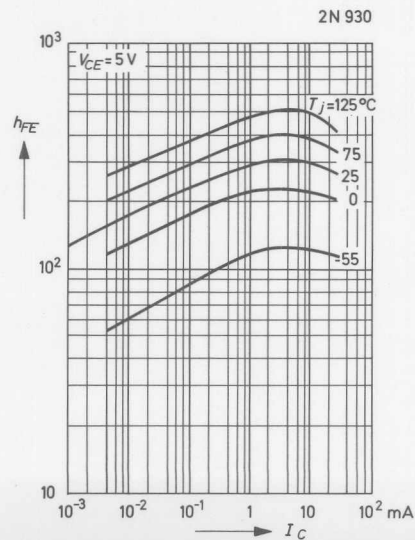
**Common emitter
collector characteristics**



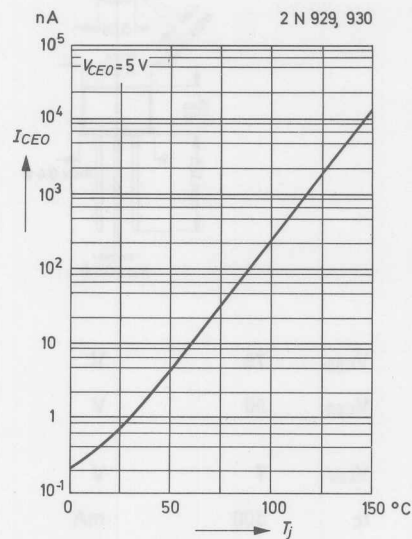
**Collector current versus
base emitter voltage**



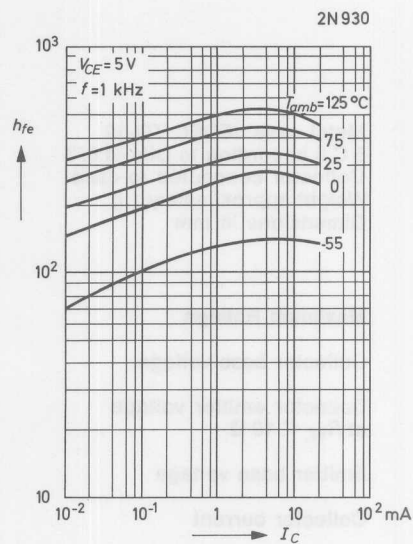
**DC current gain
versus collector current**



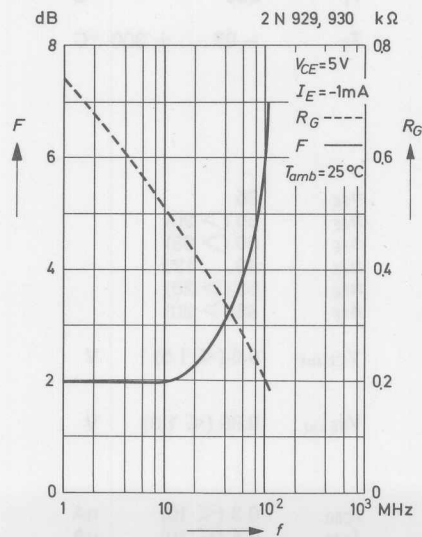
Collector cutoff current
versus junction temperature



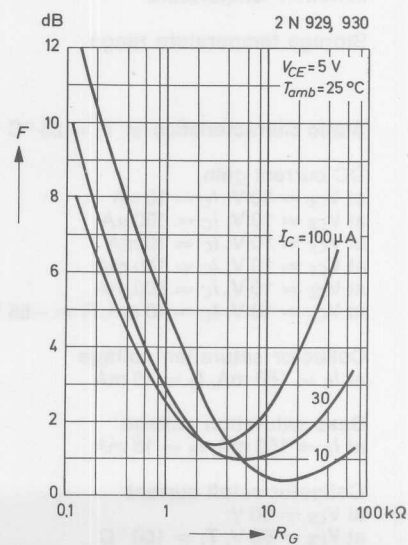
Small signal current gain
versus collector current



Noise figure
versus frequency



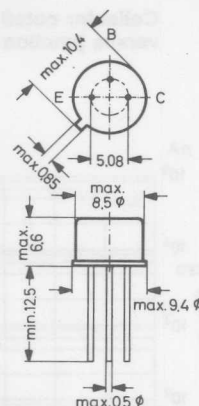
Noise figure versus
generator resistance



2 N 1613

NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	75	V
Collector emitter voltage at $R_{BE} < 10 \Omega$	V_{CER}	50	V
Emitter base voltage	V_{EB0}	7	V
Collector current	I_C	500	mA
Power dissipation at $T_{amb} = 25^\circ\text{C}$ at $T_C = 25^\circ\text{C}$	P_{tot} P_{tot}	0.8 3	W W
Junction temperature	T_j	200	$^\circ\text{C}$
Storage temperature range	T_S	$-65 \dots +300^\circ\text{C}$	

Static characteristics at $T_j = 25^\circ\text{C}$

DC current gain	h_{FE}	35	
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ }\mu\text{A}$	h_{FE}	50 (> 20)	
at $V_{CE} = 10\text{ V}$, $I_C = 100\text{ }\mu\text{A}$	h_{FE}	80 (> 35)	
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$	h_{FE}	40 ... 120	
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$	h_{FE}	55 (> 20)	
at $V_{CE} = 10\text{ V}$, $I_C = 500\text{ mA}$	h_{FE}	35 (> 20)	
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$, $T_j = -55^\circ\text{C}$	h_{FE}		
Collector saturation voltage at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$	$V_{CE\text{ sat}}$	0.6 (< 1.5)	V
Base saturation voltage at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$	$V_{BE\text{ sat}}$	0.95 (< 1.3)	V
Collector cutoff current at $V_{CB} = 60\text{ V}$	I_{CB0}	0.3 (< 10)	nA
at $V_{CB} = 60\text{ V}$, $T_j = 150^\circ\text{C}$	I_{CB0}	0.4 (< 10)	μA

Emitter cutoff current
at $V_{EB} = 5 \text{ V}$

I_{EB0} 0.05 (< 10) nA

Thermal resistance
Junction to ambient air
Junction to case

R_{thA} < 220 °C/W
 R_{thC} < 58 °C/W

Dynamic characteristics at $T_{amb} = 25 \text{ °C}$

Collector base capacitance
at $V_{CB} = 10 \text{ V}$

C_{CB0} 18 (< 25) pF

Gain bandwidth product
at $V_{CE} = 10 \text{ V}$, $I_C = 50 \text{ mA}$

f_T 80 (> 60) MHz

h-parameters, grounded emitter

Test conditions: $V_{CE} = 5 \text{ V}$, $I_C = 1 \text{ mA}$, $f = 1 \text{ kHz}$

Input impedance

h_{ie} 2.2 kΩ

Reverse voltage transfer ratio

h_{re} $3.6 \cdot 10^{-4}$

Small signal current gain

h_{fe} 30 ... 100

Output admittance

h_{oe} 12.5 μmho

h-parameters at $f = 1 \text{ kHz}$,
grounded base

Input impedance

at $V_{CB} = 5 \text{ V}$, $-I_E = 1 \text{ mA}$
at $V_{CB} = 10 \text{ V}$, $-I_E = 5 \text{ mA}$

h_{ib} 24 ... 34 Ω
 h_{ib} 4 ... 8 Ω

Reverse voltage transfer ratio

at $V_{CB} = 5 \text{ V}$, $-I_E = 1 \text{ mA}$
at $V_{CB} = 10 \text{ V}$, $-I_E = 5 \text{ mA}$

h_{rb} $0.7 (< 3) \cdot 10^{-4}$
 h_{rb} $0.8 (< 3) \cdot 10^{-4}$

Output admittance

at $V_{CB} = 5 \text{ V}$, $-I_E = 1 \text{ mA}$
at $V_{CB} = 10 \text{ V}$, $-I_E = 5 \text{ mA}$

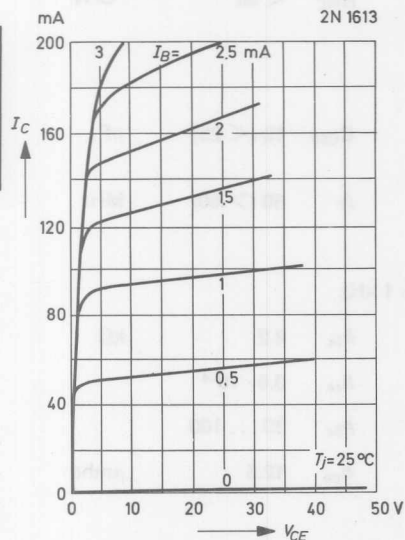
h_{ob} 0.1 ... 0.5 μmho
 h_{ob} 0.1 ... 1 μmho

Noise figure

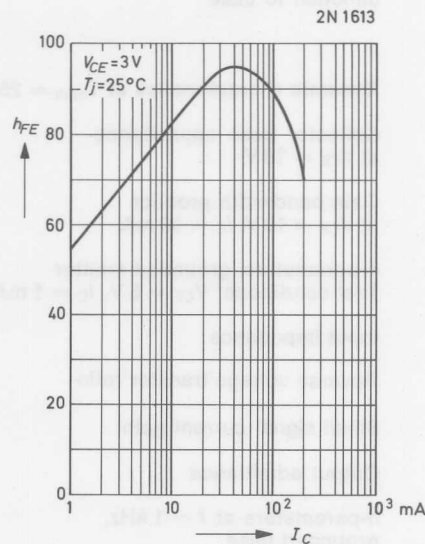
at $V_{CE} = 10 \text{ V}$, $I_C = 0.3 \text{ mA}$,
 $R_G = 500 \text{ Ω}$, $f = 1 \text{ kHz}$

F 6 (< 12) dB

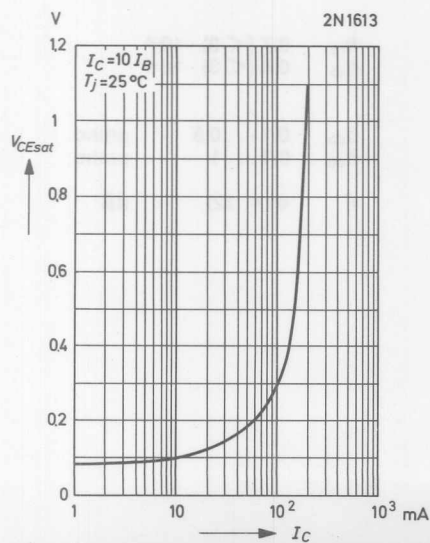
**Common emitter
collector characteristics**



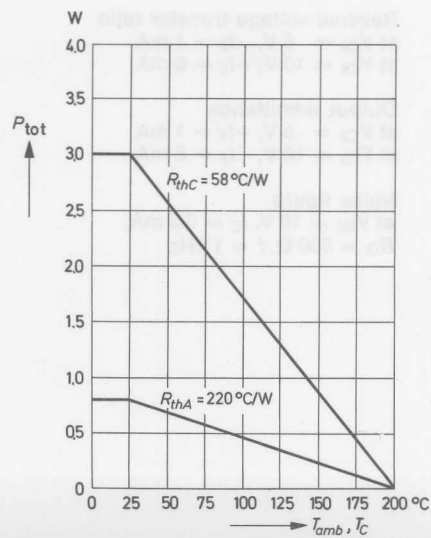
**DC current gain
versus collector current**



**Collector saturation voltage
versus collector current**



**Admissible power dissipation
versus temperature**





NOTE: Silicon Epitaxial Power Transistor
for switching and amplifier applications

Mount case 185C TO-18
S.C. according to DIN 41712
Collector connected to case
Weight approximately 1 g
Operation in air

Electrical Ratings

Collector base voltage

Collector emitter voltage
at $I_{CE} < 100$ mA

Emitter base voltage

Collector current

Power dissipation
at $T_{amb} = 25^{\circ}\text{C}$
at $T_c = 25^{\circ}\text{C}$

Junction temperature

Storage temperature range

DC characteristics at $T_c = 25^{\circ}\text{C}$

DC current gain

at $V_{CE} = 10$ V, $I_C = 10$ mA
at $V_{CE} = 10$ V, $I_C = 100$ mA
at $V_{CE} = 10$ V, $I_C = 10$ mA
at $V_{CE} = 10$ V, $I_C = 100$ mA
at $V_{CE} = 10$ V, $I_C = 100$ mA
at $V_{CE} = 10$ V, $I_C = 100$ mA
at $V_{CE} = 10$ V, $I_C = 100$ mA

Collector saturation voltage
at $I_C = 100$ mA, $V_{BE} = 10$ V

Base saturation voltage
at $I_C = 100$ mA, $V_{BE} = 10$ V

Collector cutoff current

at $V_{CE} = 10$ V
at $V_{CE} = 10$ V, $T_c = 100^{\circ}\text{C}$

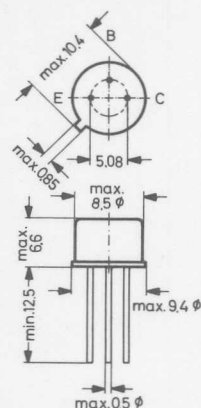
V_{CB}	15	V
V_{CE}	30	V
V_{EB}	7	V
I_C	200	mA
P_{tot}	0.8	W
P_{tot}	3	W
T_j	200	$^{\circ}\text{C}$
T_s	- 55 ... + 200	$^{\circ}\text{C}$

h_{FE}	100	
h_{FE}	100	
h_{FE}	100	
h_{FE}	100	
h_{FE}	100	
h_{FE}	100	
h_{FE}	100	
$V_{CE(sat)}$	0.8 (1.0)	V
$V_{BE(sat)}$	0.8 (1.0)	V
I_{CO}	0.1 (0.1)	mA
I_{CO}	0.1 (0.1)	mA

2 N 1711

NPN Silicon Epitaxial Planar Transistor
for switching and amplifier applications

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	75	V
Collector emitter voltage at $R_{BE} < 10 \Omega$	V_{CER}	50	V
Emitter base voltage	V_{EB0}	7	V
Collector current	I_C	500	mA
Power dissipation at $T_{amb} = 25^\circ\text{C}$ at $T_C = 25^\circ\text{C}$	P_{tot} P_{tot}	0.8 3	W W
Junction temperature	T_j	200	$^\circ\text{C}$
Storage temperature range	T_S	- 65 ... + 300	$^\circ\text{C}$

Static characteristics at $T_j = 25^\circ\text{C}$

DC current gain at $V_{CE} = 10 \text{ V}$, $I_C = 10 \mu\text{A}$ at $V_{CE} = 10 \text{ V}$, $I_C = 100 \mu\text{A}$ at $V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$ at $V_{CE} = 10 \text{ V}$, $I_C = 150 \text{ mA}$ at $V_{CE} = 10 \text{ V}$, $I_C = 500 \text{ mA}$ at $V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$, $T_j = -55^\circ\text{C}$	h_{FE} h_{FE} h_{FE} h_{FE} h_{FE} h_{FE}	60 (> 20) 80 (> 35) 130 (> 75) 100 ... 300 75 (> 40) 65 (> 35)	
Collector saturation voltage at $I_C = 150 \text{ mA}$, $I_B = 15 \text{ mA}$	$V_{CE sat}$	0.5 (< 1.5)	V
Base saturation voltage at $I_C = 150 \text{ mA}$, $I_B = 15 \text{ mA}$	$V_{BE sat}$	0.95 (< 1.3)	V
Collector cutoff current at $V_{CB} = 60 \text{ V}$ at $V_{CB} = 60 \text{ V}$, $T_j = 150^\circ\text{C}$	I_{CB0} I_{CB0}	0.3 (< 10) 0.4 (< 10)	nA μA

Emitter cutoff current
at $V_{EB} = 5\text{ V}$

I_{EB0} 0.05 (< 5) nA

Thermal resistance
Junction to ambient air
Junction to case

R_{thA} < 220 °C/W
 R_{thC} < 58 °C/W

Dynamic characteristics at $T_{amb} = 25\text{ °C}$

Collector base capacitance
at $V_{CB} = 10\text{ V}$

C_{CB0} 18 (< 25) pF

Gain bandwidth product
at $V_{CE} = 10\text{ V}$, $I_C = 50\text{ mA}$

f_T 100 (> 70) MHz

h-parameters, grounded emitter

Test conditions: $V_{CE} = 5\text{ V}$, $I_C = 1\text{ mA}$, $f = 1\text{ kHz}$

Input impedance

h_{ie} 4.4 kΩ

Reverse voltage transfer ratio

h_{re} $7.3 \cdot 10^{-4}$

Small signal current gain

h_{fe} 50 ... 200

Output admittance

h_{oe} 23.8 μmho

h-parameters at $f = 1\text{ kHz}$,
grounded base

Input impedance

at $V_{CB} = 5\text{ V}$, $-I_E = 1\text{ mA}$
at $V_{CB} = 10\text{ V}$, $-I_E = 5\text{ mA}$

h_{ib} 24 ... 34 Ω
 h_{ib} 4 ... 8 Ω

Reverse voltage transfer ratio

at $V_{CB} = 5\text{ V}$, $-I_E = 1\text{ mA}$
at $V_{CB} = 10\text{ V}$, $-I_E = 5\text{ mA}$

h_{rb} $1.2 (< 5) \cdot 10^{-4}$
 h_{rb} $1.2 (< 5) \cdot 10^{-4}$

Output admittance

at $V_{CB} = 5\text{ V}$, $-I_E = 1\text{ mA}$
at $V_{CB} = 10\text{ V}$, $-I_E = 5\text{ mA}$

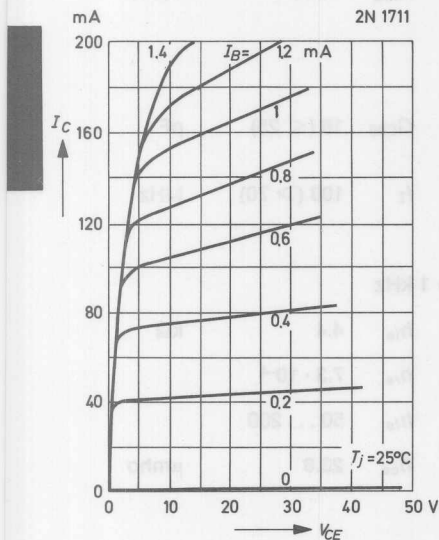
h_{ob} 0.1 ... 0.5 μmho
 h_{ob} 0.1 ... 1 μmho

Noise figure

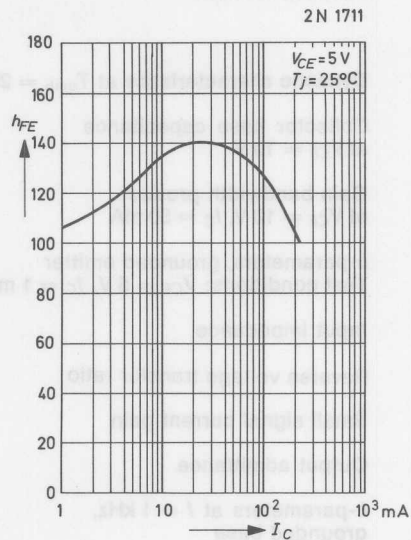
at $V_{CE} = 10\text{ V}$, $I_C = 0.3\text{ mA}$,
 $R_G = 500\text{ Ω}$, $f = 1\text{ kHz}$

F 3.5 (< 8) dB

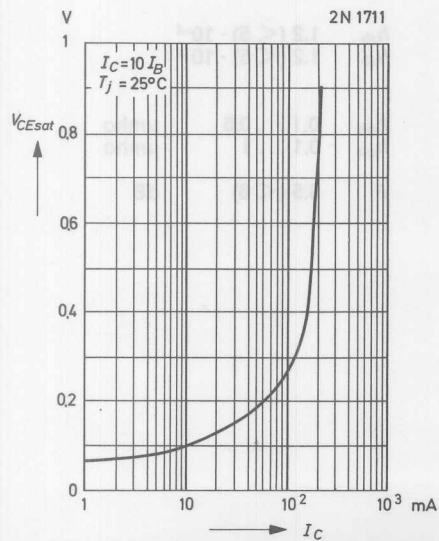
Common emitter collector characteristics



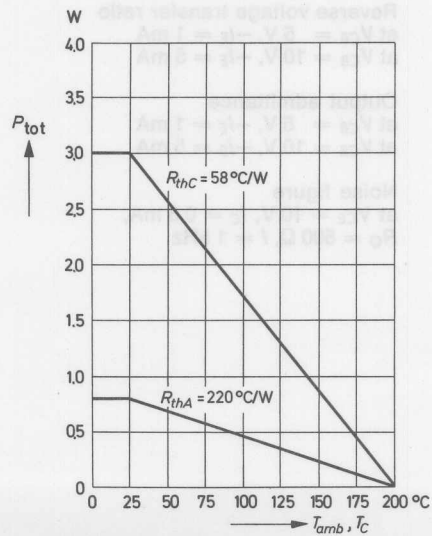
DC current gain versus collector current



Collector saturation voltage versus collector current



Admissible power dissipation versus temperature



High Silicon Epitaxial Planar Transistor
for switching and amplifier applications



Model case JEDEC TO-18
S C 3 according to DIN 14575
Collector connected to case
Weight approximately 1 g
Dimensions in mm

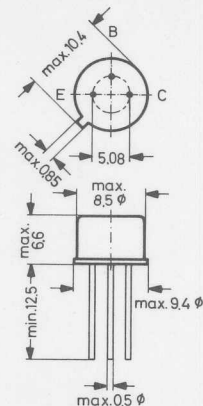
Maximum Ratings		
Collector base voltage	V_{CB}	150 V
Collector emitter voltage	V_{CE}	50 V
at $I_C = 5$ mA	V_{CE}	100 V
at $P_{tot} < 100$ mW	V_{CE}	7 V
Emitter base voltage	V_{EB}	7 V
Collector current	I_C	500 mA
Power dissipation	P_{tot}	0.8 W
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	3 W
at $T_C = 25^\circ\text{C}$	T_J	200 $^\circ\text{C}$
Junction temperature	T_J	-55 ... +200 $^\circ\text{C}$
Storage temperature range	T_s	-55 ... +200 $^\circ\text{C}$

Static Characteristics at $T_J = 25^\circ\text{C}$

DC current gain		
at $V_{CE} = 10$ V, $I_C = 5$ mA	β_{DC}	80
at $V_{CE} = 10$ V, $I_C = 10$ mA	β_{DC}	80
at $V_{CE} = 10$ V, $I_C = 100$ mA	β_{DC}	40
at $V_{CE} = 10$ V, $I_C = 10$ mA, $T_J = 55^\circ\text{C}$	β_{DC}	40
Collector saturation voltage		
at $I_C = 150$ mA, $I_E = 15$ mA	$V_{CE(sat)}$	0.2 V
at $I_C = 50$ mA, $I_E = 5$ mA	$V_{CE(sat)}$	0.2 V
Base saturation voltage		
at $I_C = 150$ mA, $I_E = 15$ mA	$V_{BE(sat)}$	0.8 V
at $I_C = 50$ mA, $I_E = 5$ mA	$V_{BE(sat)}$	0.8 V

NPN Silicon Epitaxial Planar Transistor
 for switching and amplifier applications

Metal case JEDEC TO-39
 5 C 3 according to DIN 41 873
 Collector connected to case
 Weight approximately 1 g
 Dimensions in mm


Maximum Ratings

Collector base voltage	V_{CB0}	120	V
Collector emitter voltage at $I_B = 0$	V_{CE0}	80	V
at $R_{BE} < 10 \Omega$	V_{CER}	100	V
Emitter base voltage	V_{EB0}	7	V
Collector current	I_C	500	mA
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 25^\circ\text{C}$	P_{tot}	3	W
Junction temperature	T_j	200	$^\circ\text{C}$
Storage temperature range	T_S	$-65 \dots +300^\circ\text{C}$	

Static Characteristics at $T_j = 25^\circ\text{C}$

DC current gain at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$	h_{FE}	50 (> 20)	
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$	h_{FE}	80 (> 35)	
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$	h_{FE}	40 ... 120	
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$, $T_j = -55^\circ\text{C}$	h_{FE}	40 (> 20)	
Collector saturation voltage at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$	$V_{CE sat}$	2 (< 5)	V
at $I_C = 50\text{ mA}$, $I_B = 5\text{ mA}$	$V_{CE sat}$	0.5 (< 1.2)	V
Base saturation voltage at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$	$V_{BE sat}$	0.96 (< 1.3)	V
at $I_C = 50\text{ mA}$, $I_B = 5\text{ mA}$	$V_{BE sat}$	0.82 (< 0.9)	V

Collector cutoff current
at $V_{CB} = 90 \text{ V}$
at $V_{CB} = 90 \text{ V}$, $T_j = 150^\circ\text{C}$

I_{CB0} 0.3 (< 10) nA
 I_{CB0} 1.5 (< 15) μA

Emitter cutoff current
at $V_{EB} = 5 \text{ V}$

I_{EB0} < 10 nA

Thermal resistance
Junction to ambient air
Junction to case

R_{thA} < 220 $^\circ\text{C/W}$
 R_{thC} < 58 $^\circ\text{C/W}$

Dynamic characteristics at $T_C = 25^\circ\text{C}$

Collector base capacitance
at $V_{CB} = 10 \text{ V}$

C_{CB0} < 15 pF

Gain bandwidth product
at $V_{CE} = 10 \text{ V}$, $I_C = 50 \text{ mA}$

f_T 70 (> 50) MHz

Small signal current gain
at $V_{CE} = 10 \text{ V}$, $I_C = 5 \text{ mA}$, $f = 1 \text{ kHz}$

h_{fe} > 45

h -parameters, grounded base
Test conditions: $V_{CE} = 5 \text{ V}$, $-I_E = 1 \text{ mA}$, $f = 1 \text{ kHz}$

Input impedance

h_{ib} 20 ... 30 Ω

Reverse voltage transfer ratio

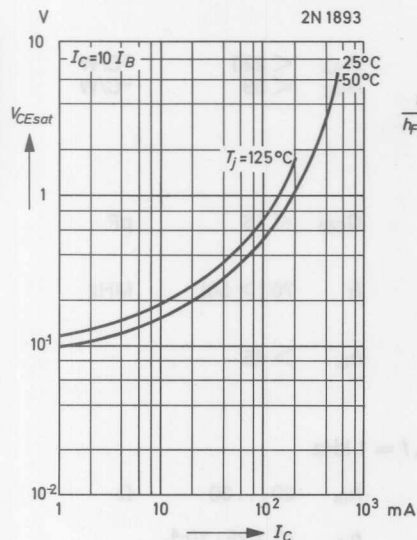
h_{rb} $< 1.25 \cdot 10^{-4}$

Output admittance

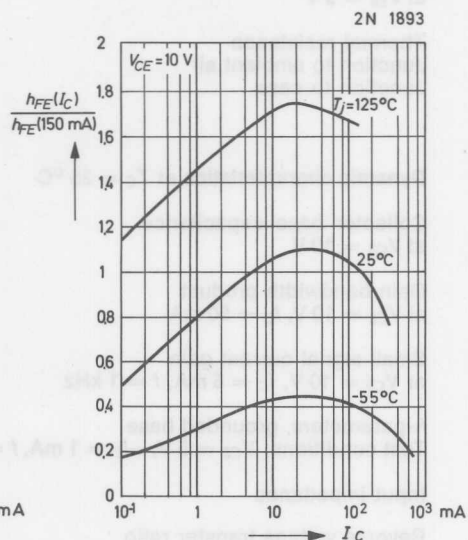
h_{ob} < 0.5 μmho



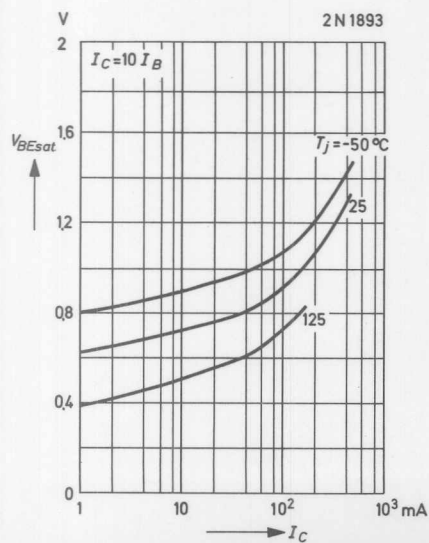
Collector saturation voltage
versus collector current



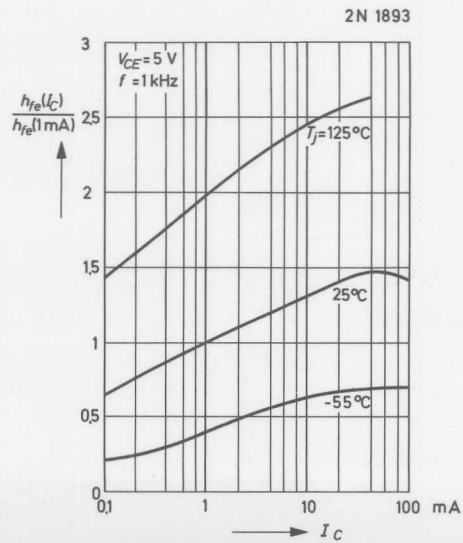
Relative DC current gain
versus collector current



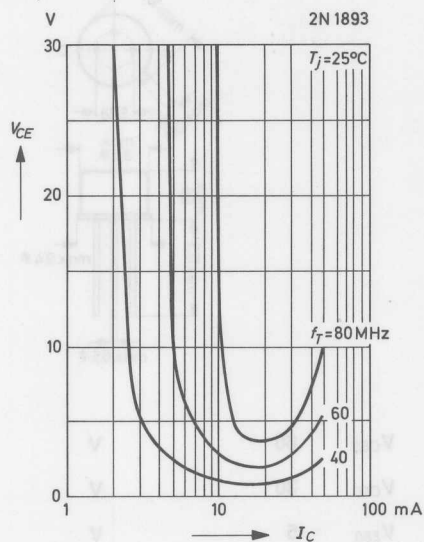
Base saturation voltage
versus collector current



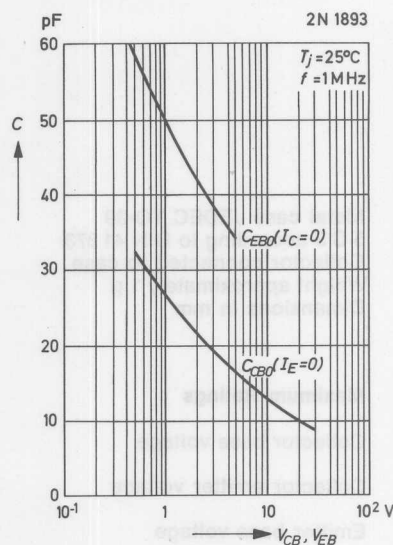
Relative small signal current
gain versus collector current



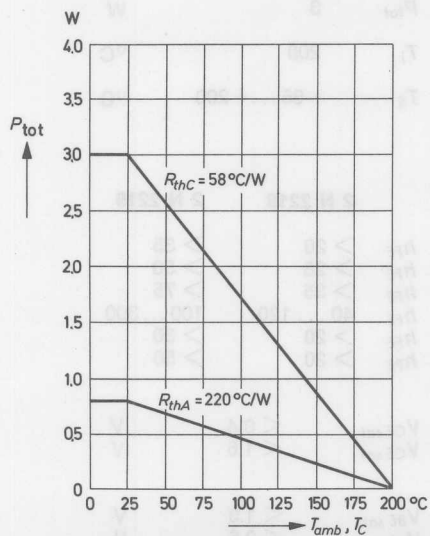
Contours of constant gain bandwidth product



Collector base capacitance, Emitter base capacitance versus reverse bias voltage



Admissible power dissipation versus temperature

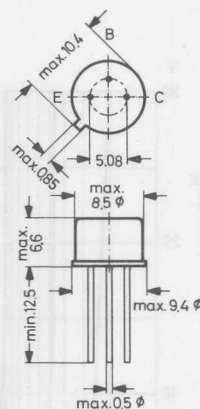


2 N 2218, 2 N 2219

NPN Silicon Epitaxial Planar Transistors

with high cutoff frequency, for high speed switching

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	60	V
Collector emitter voltage	V_{CE0}	30	V
Emitter base voltage	V_{EB0}	5	V
Collector current	I_C	0.8	A
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 25^\circ\text{C}$	P_{tot}	3	W
Junction temperature	T_j	200	$^\circ\text{C}$
Storage temperature range	T_S	$-65 \dots +200$	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$
at $V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$
at $V_{CE} = 10\text{ V}$, $I_C = 0.5\text{ A}$
at $V_{CE} = 1\text{ V}$, $I_C = 150\text{ mA}$

Collector saturation voltage

at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$
at $I_C = 500\text{ mA}$, $I_B = 50\text{ mA}$

Base saturation voltage

at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$
at $I_C = 500\text{ mA}$, $I_B = 50\text{ mA}$

2 N 2218

h_{FE}	> 20
h_{FE}	> 25
h_{FE}	> 35
h_{FE}	$40 \dots 120$
h_{FE}	> 20
h_{FE}	> 20

2 N 2219

h_{FE}	> 35
h_{FE}	> 50
h_{FE}	> 75
h_{FE}	$100 \dots 300$
h_{FE}	> 30
h_{FE}	> 50

$V_{CE\text{ sat}}$	< 0.4	V
$V_{CE\text{ sat}}$	< 1.6	V

$V_{BE\text{ sat}}$	< 1.3	V
$V_{BE\text{ sat}}$	< 2.6	V

Collector cutoff current at $V_{CB} = 50 \text{ V}$	I_{CB0}	< 10	nA
at $V_{CB} = 50 \text{ V}$, $T_{amb} = 150^\circ\text{C}$	I_{CB0}	< 10	μA
Collector base breakdown voltage at $I_C = 10 \mu\text{A}$	$V_{(BR)CB0}$	> 60	V
Collector emitter breakdown voltage at $I_C = 10 \text{ mA}$	$V_{(BR)CE0}$	> 30	V
Emitter base breakdown voltage at $I_E = 10 \mu\text{A}$	$V_{(BR)EB0}$	> 5	V
Gain bandwidth product at $V_{CE} = 20 \text{ V}$, $I_C = 20 \text{ mA}$, $f = 100 \text{ MHz}$	f_T	> 250	MHz
Collector base capacitance at $V_{CB0} = 10 \text{ V}$, $f = 100 \text{ kHz}$	C_{CB0}	< 8	pF
Emitter base capacitance at $V_{EB0} = 0.5 \text{ V}$, $f = 100 \text{ kHz}$	C_{EB0}	< 30	pF
Thermal resistance Junction to ambient air	R_{thA}	< 220	$^\circ\text{C/W}$
Junction to case	R_{thC}	< 58	$^\circ\text{C/W}$
Turn-on time (see Fig. 1)	t_{on}	26	ns
Turn-off time (see Fig. 2)	t_{off}	70	ns
Total switching time (see Fig. 3)	t_{total}	12	ns

Curves and characteristics of types BSW 82...85 are valid analogously for types 2 N 2218 and 2 N 2219.

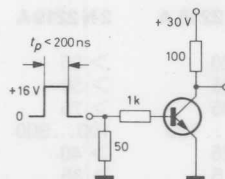


Fig. 1: Test circuit
for turn-on time,
saturated operation

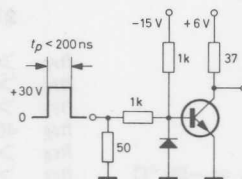


Fig. 2: Test circuit
for turn-off time,
saturated operation

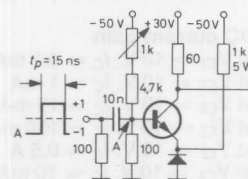


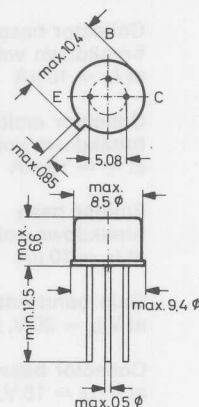
Fig. 3: Test circuit
for non-saturated
operation

2 N 2218 A, 2 N 2219 A

NPN Silicon Epitaxial Planar Transistors

with high cutoff frequency, for high speed switching

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	75	V
Collector emitter voltage	V_{CE0}	40	V
Emitter base voltage	V_{EB0}	6	V
Collector current	I_C	0.8	A
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 25^\circ\text{C}$	P_{tot}	3	W
Junction temperature	T_j	200	$^\circ\text{C}$
Storage temperature range	T_s	-65 ... +200	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

	2 N 2218 A	2N2219A
at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$	$h_{FE} > 20$	> 35
at $V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$	$h_{FE} > 25$	> 50
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$	$h_{FE} > 35$	> 75
at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$	$h_{FE} 40 \dots 120$	$100 \dots 300$
at $V_{CE} = 10\text{ V}$, $I_C = 0.5\text{ A}$	$h_{FE} > 25$	> 40
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$, $T_j = -55^\circ\text{C}$	$h_{FE} > 15$	> 35
at $V_{CE} = 1\text{ V}$, $I_C = 150\text{ mA}$	$h_{FE} > 20$	> 50

Collector saturation voltage

at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$	$V_{CE\text{ sat}}$	< 0.3	V
at $I_C = 500\text{ mA}$, $I_B = 50\text{ mA}$	$V_{CE\text{ sat}}$	< 1	V

Base saturation voltage

at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$	$V_{BE\text{ sat}}$	< 1.2	V
at $I_C = 500\text{ mA}$, $I_B = 50\text{ mA}$	$V_{BE\text{ sat}}$	< 2	V

2 N 2218 A, 2 N 2219 A

Collector cutoff current at $V_{CB} = 60 \text{ V}$	I_{CBO}	< 10	nA
at $V_{CB} = 60 \text{ V}$, $T_{amb} = 150^\circ \text{C}$	I_{CBO}	< 10	μA
at $V_{CE} = 60 \text{ V}$, $V_{EB} = 3 \text{ V}$	I_{CEV}	< 10	nA
Emitter cutoff current at $V_{EB} = 3 \text{ V}$	I_{EBO}	< 10	nA
Base cutoff current at $V_{CE} = 60 \text{ V}$, $V_{EB} = 3 \text{ V}$	I_{EBV}	< 20	nA
Collector base breakdown voltage at $I_C = 10 \mu\text{A}$	$V_{(BR)CB0}$	> 75	V
Collector emitter breakdown voltage at $I_C = 10 \text{ mA}$	$V_{(BR)CE0}$	> 40	V
Emitter base breakdown voltage at $I_E = 10 \mu\text{A}$	$V_{(BR)EB0}$	> 6	V

h -parameters at $f = 1 \text{ kHz}$

		2 N 2218 A	2 N 2219 A	
Input impedance				
at $V_{CE} = 10 \text{ V}$, $I_C = 1 \text{ mA}$	h_{ie}	1 ... 3.5	2 ... 8	k Ω
at $V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$	h_{ie}	0.2 ... 1	0.25 ... 1.25	k Ω
Reverse voltage transfer ratio				
at $V_{CE} = 10 \text{ V}$, $I_C = 1 \text{ mA}$	h_{re}	$< 5 \cdot 10^{-4}$	$< 8 \cdot 10^{-4}$	
at $V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$	h_{re}	$< 2.5 \cdot 10^{-4}$	$< 4 \cdot 10^{-4}$	
Small signal current gain				
at $V_{CE} = 10 \text{ V}$, $I_C = 1 \text{ mA}$	h_{fe}	30 ... 150	50 ... 300	
at $V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$	h_{fe}	50 ... 300	75 ... 375	
Output admittance				
at $V_{CE} = 10 \text{ V}$, $I_C = 1 \text{ mA}$	h_{oe}	3 ... 15	5 ... 35	μmho
at $V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$	h_{oe}	10 ... 100	25 ... 200	μmho
Collector base time constant at $V_{CE} = 20 \text{ V}$, $I_C = 20 \text{ mA}$, $f = 31.8 \text{ MHz}$	$r_b \cdot C_c$	< 150	< 150	ps
Noise figure at $V_{CE} = 10 \text{ V}$, $I_C = 0.1 \text{ mA}$, $R_G = 1 \text{ k}\Omega$, $f = 1 \text{ kHz}$	F	—	< 4	dB
Thermal resistance				
Junction to ambient air	R_{thA}	< 220		$^\circ\text{C/W}$
Junction to case	R_{thC}	< 58		$^\circ\text{C/W}$

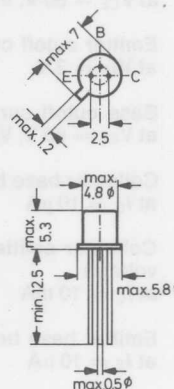
Curves and characteristics of types BSW 82 ... 85 are valid analogously for types 2 N 2218 A and 2 N 2219 A.

2 N 2221, 2 N 2222

NPN Silicon Epitaxial Planar Transistors

with high cutoff frequency, for high speed switching

Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	60	V
Collector emitter voltage	V_{CE0}	30	V
Emitter base voltage	V_{EB0}	5	V
Collector current	I_C	0.8	A
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.5	W
at $T_C = 25^\circ\text{C}$	P_{tot}	1.8	W
Junction temperature	T_j	175	$^\circ\text{C}$
Storage temperature range	T_S	-65 ... + 200	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $V_{CE} = 10\text{ V}$, $I_C = 0.1\text{ mA}$

at $V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$

at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$

at $V_{CE} = 10\text{ V}$, $I_C = 150\text{ mA}$

at $V_{CE} = 10\text{ V}$, $I_C = 0.5\text{ A}$

	2 N 2221	2 N 2222
h_{FE}	> 20	> 35
h_{FE}	> 25	> 50
h_{FE}	> 35	> 75
h_{FE}	40 ... 120	100 ... 300
h_{FE}	> 20	> 30

Collector saturation voltage

at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$

at $I_C = 500\text{ mA}$, $I_B = 50\text{ mA}$

$V_{CE\text{ sat}}$	< 0.4	V
$V_{CE\text{ sat}}$	< 1.6	V

Base saturation voltage

at $I_C = 150\text{ mA}$, $I_B = 15\text{ mA}$

at $I_C = 500\text{ mA}$, $I_B = 50\text{ mA}$

$V_{BE\text{ sat}}$	< 1.3	V
$V_{BE\text{ sat}}$	< 2.6	V

Collector cutoff current
at $V_{CB} = 50 \text{ V}$
at $V_{CB} = 50 \text{ V}$, $T_{amb} = 150^\circ\text{C}$

$I_{CB0} < 10 \text{ nA}$
 $I_{CB0} < 10 \text{ }\mu\text{A}$

Collector base
breakdown voltage
at $I_C = 10 \text{ }\mu\text{A}$

$V_{(BR)CB0} > 60 \text{ V}$

Collector emitter
breakdown voltage
at $I_C = 10 \text{ mA}$

$V_{(BR)CE0} > 30 \text{ V}$

Emitter base
breakdown voltage
at $I_E = 10 \text{ }\mu\text{A}$

$V_{(BR)EB0} > 5 \text{ V}$

Gain bandwidth product
at $V_{CE} = 20 \text{ V}$, $I_C = 20 \text{ mA}$, $f = 100 \text{ MHz}$

$f_T > 250 \text{ MHz}$

Collector base capacitance
at $V_{CB0} = 10 \text{ V}$, $f = 100 \text{ kHz}$

$C_{CB0} < 8 \text{ pF}$

Emitter base capacitance
at $V_{EB0} = 0.5 \text{ V}$, $f = 100 \text{ kHz}$

$C_{EB0} < 30 \text{ pF}$

Thermal resistance
Junction to ambient air
Junction to case

$R_{thA} < 300^\circ\text{C/W}$
 $R_{thC} < 84^\circ\text{C/W}$

Turn-on time
(see Fig. 1)

$t_{on} = 26 \text{ ns}$

Turn-off time
(see Fig. 2)

$t_{off} = 70 \text{ ns}$

Total switching time
(see Fig. 3)

$t_{total} = 12 \text{ ns}$

Curves and characteristics of types BSW 82...85 are valid analogously for types 2 N 2221 and 2 N 2222.

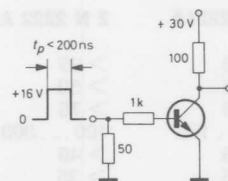


Fig. 1: Test circuit for turn-on time, saturated operation

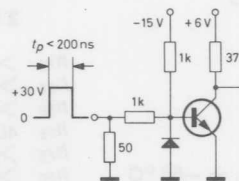


Fig. 2: Test circuit for turn-off time, saturated operation

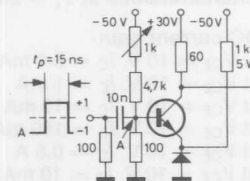


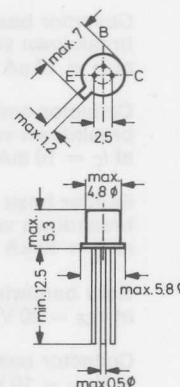
Fig. 3: Test circuit for non-saturated operation

2 N 2221 A, 2 N 2222 A

NPN Silicon Epitaxial Planar Transistors

with high cutoff frequency, for high speed switching

Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	75	V
Collector emitter voltage	V_{CE0}	40	V
Emitter base voltage	V_{EB0}	6	V
Collector current	I_C	0.8	A
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.5	W
at $T_C = 25^\circ\text{C}$	P_{tot}	1.8	W
Junction temperature	T_j	175	$^\circ\text{C}$
Storage temperature range	T_S	$-65 \dots +200^\circ\text{C}$	

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

	2 N 2221 A	2 N 2222 A
at $V_{CE} = 10\text{ V}, I_C = 0.1\text{ mA}$	$h_{FE} > 20$	> 35
at $V_{CE} = 10\text{ V}, I_C = 1\text{ mA}$	$h_{FE} > 25$	> 50
at $V_{CE} = 10\text{ V}, I_C = 10\text{ mA}$	$h_{FE} > 35$	> 75
at $V_{CE} = 10\text{ V}, I_C = 150\text{ mA}$	$h_{FE} 40 \dots 120$	$100 \dots 300$
at $V_{CE} = 10\text{ V}, I_C = 0.5\text{ A}$	$h_{FE} > 25$	> 40
at $V_{CE} = 10\text{ V}, I_C = 10\text{ mA}, T_j = -55^\circ\text{C}$	$h_{FE} > 15$	> 35
at $V_{CE} = 1\text{ V}, I_C = 150\text{ mA}$	$h_{FE} > 20$	> 50

Collector saturation voltage

at $I_C = 150\text{ mA}, I_B = 15\text{ mA}$	$V_{CE\text{ sat}}$	< 0.3	V
at $I_C = 500\text{ mA}, I_B = 50\text{ mA}$	$V_{CE\text{ sat}}$	< 1	V

Base saturation voltage

at $I_C = 150\text{ mA}, I_B = 15\text{ mA}$	$V_{BE\text{ sat}}$	< 1.2	V
at $I_C = 500\text{ mA}, I_B = 50\text{ mA}$	$V_{BE\text{ sat}}$	< 2	V

2 N 2221 A, 2 N 2222 A

Collector cutoff current at $V_{CB} = 60 \text{ V}$	I_{CBO}	< 10	nA
at $V_{CB} = 60 \text{ V}$, $T_{amb} = 150^\circ \text{C}$	I_{CBO}	< 10	μA
at $V_{CE} = 60 \text{ V}$, $V_{EB} = 3 \text{ V}$	I_{CEV}	< 10	nA
Emitter cutoff current at $V_{EB} = 3 \text{ V}$	I_{EBO}	< 10	nA
Base cutoff current at $V_{CE} = 60 \text{ V}$, $V_{EB} = 3 \text{ V}$	I_{EBV}	< 20	nA
Collector base breakdown voltage at $I_C = 10 \mu\text{A}$	$V_{(BR)CB0}$	> 75	V
Collector emitter breakdown voltage at $I_C = 10 \text{ mA}$	$V_{(BR)CE0}$	> 40	V
Emitter base breakdown voltage at $I_E = 10 \mu\text{A}$	$V_{(BR)EB0}$	> 6	V

h-parameters at $f = 1 \text{ kHz}$

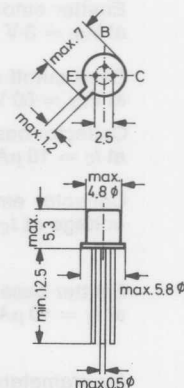
	2 N 2221 A	2 N 2222 A	
Input impedance at $V_{CE} = 10 \text{ V}$, $I_C = 1 \text{ mA}$	h_{ie}	1 ... 3.5	k Ω
at $V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$	h_{ie}	0.2 ... 1	0.25 ... 1.25 k Ω
Reverse voltage transfer ratio at $V_{CE} = 10 \text{ V}$, $I_C = 1 \text{ mA}$	h_{re}	$< 5 \cdot 10^{-4}$	$< 8 \cdot 10^{-4}$
at $V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$	h_{re}	$< 2.5 \cdot 10^{-4}$	$< 4 \cdot 10^{-4}$
Small signal current gain at $V_{CE} = 10 \text{ V}$, $I_C = 1 \text{ mA}$	h_{fe}	30 ... 150	50 ... 300
at $V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$	h_{fe}	50 ... 300	75 ... 375
Output admittance at $V_{CE} = 10 \text{ V}$, $I_C = 1 \text{ mA}$	h_{oe}	3 ... 15	μmho
at $V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$	h_{oe}	10 ... 100	25 ... 200 μmho
Collector base time constant at $V_{CE} = 20 \text{ V}$, $I_C = 20 \text{ mA}$, $f = 31.8 \text{ MHz}$	$r_{b'} C_c$	< 150	ps
Noise figure at $V_{CE} = 10 \text{ V}$, $I_C = 0.1 \text{ mA}$, $R_G = 1 \text{ k}\Omega$, $f = 1 \text{ kHz}$	F	—	< 4 dB
Thermal resistance Junction to ambient air	R_{thA}	< 300	$^\circ\text{C/W}$
Junction to case	R_{thC}	< 84	$^\circ\text{C/W}$

Curves and characteristics of types BSW 82 ... 85 are valid analogously for types 2 N 2221 A and 2 N 2222 A.

NPN Silicon Epitaxial Planar Transistor

for switching applications at switching frequencies up to 50...100 MHz
and collector currents from 0.1 to 100 mA.

Metal case JEDEC TO-18
18 A 3 according to DIN 41876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

**Maximum Ratings**

Collector base voltage	V_{CB0}	40	V
Collector emitter voltage	V_{CES}	40	V
at $V_{BE} = 0$	V_{CE0}	15	V
at $I_B = 0$			
Emitter base voltage	V_{EB0}	4.5	V
Collector current	I_C	200	mA
Collector current, pulsed	I_C	500	mA
$t_p = 10 \mu s$ duration			
Power dissipation	P_{tot}	0.36	W
at $T_{amb} = 25^\circ C$	P_{tot}	1.2	W
at $T_C = 25^\circ C$			
Junction temperature	T_j	200	$^\circ C$
Storage temperature range	T_s	-65 ... +200	$^\circ C$

Characteristics at $T_j = 25^\circ C$

DC current gain

at $V_{CE} = 1 V, I_C = 10 mA$

at $V_{CE} = 1 V, I_C = 10 mA, T_j = -55^\circ C$

at $V_{CE} = 2 V, I_C = 100 mA$

h_{FE}	20 ... 60
h_{FE}	> 10
h_{FE}	> 10

Collector saturation voltage
at $I_C = 10 \text{ mA}$, $I_B = 1 \text{ mA}$

$V_{CE \text{ sat}}$ 0.2 (< 0.25) V

Base saturation voltage
at $I_C = 10 \text{ mA}$, $I_B = 1 \text{ mA}$

$V_{BE \text{ sat}}$ 0.7 ... 0.85 V

Collector cutoff current
at $V_{CB} = 20 \text{ V}$
at $V_{CB} = 20 \text{ V}$, $T_j = 150^\circ \text{C}$

I_{CB0} < 0.4 μA
 I_{CB0} < 30 μA

Collector base capacitance
at $V_{CB0} = 5 \text{ V}$

C_{CB0} 2.5 (< 4) pF

Gain bandwidth product
at $V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$

f_T > 400 MHz

Storage time constant
at $I_C = I_{B1} = -I_{B2} = 10 \text{ mA}$

τ_s < 10 ns

Turn-on time
at $I_C = 10 \text{ mA}$, $I_{B1} = 3 \text{ mA}$

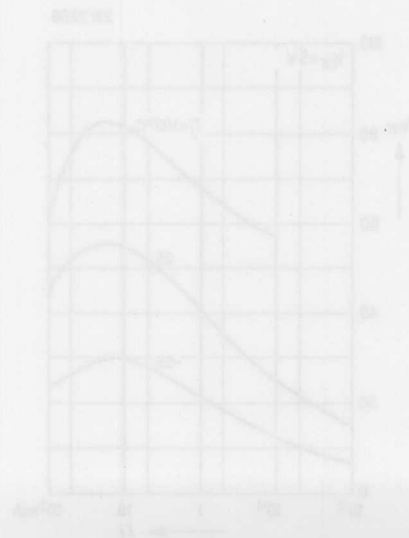
t_{on} < 12 ns

Turn-off time
at $I_C = 10 \text{ mA}$, $I_{B1} = 3 \text{ mA}$,
 $-I_{B2} = 1.5 \text{ mA}$

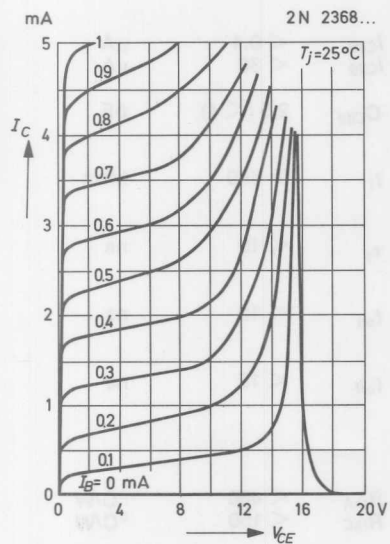
t_{off} < 15 ns

Thermal resistance
Junction to ambient air
Junction to case

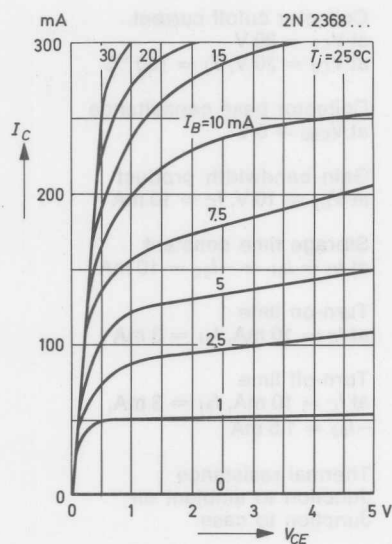
R_{thA} < 480 $^\circ\text{C/W}$
 R_{thC} < 150 $^\circ\text{C/W}$



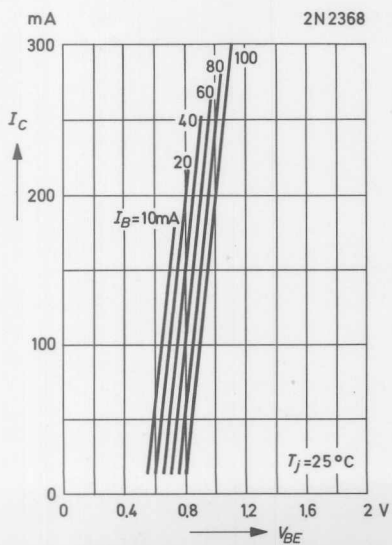
Common emitter collector characteristics



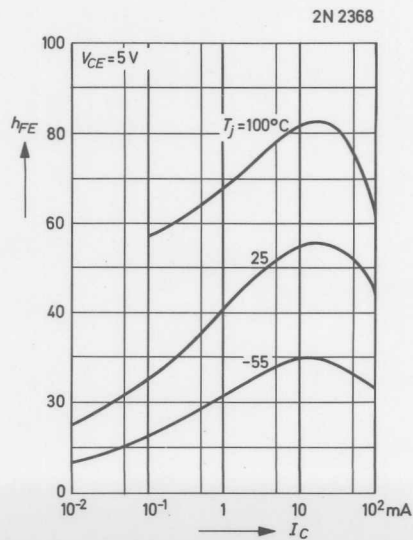
Common emitter collector characteristics



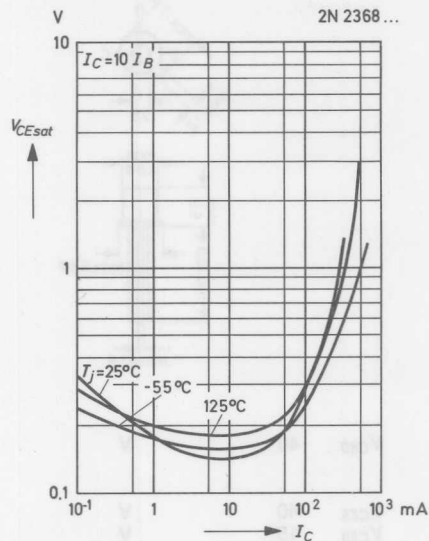
Collector current versus base emitter voltage



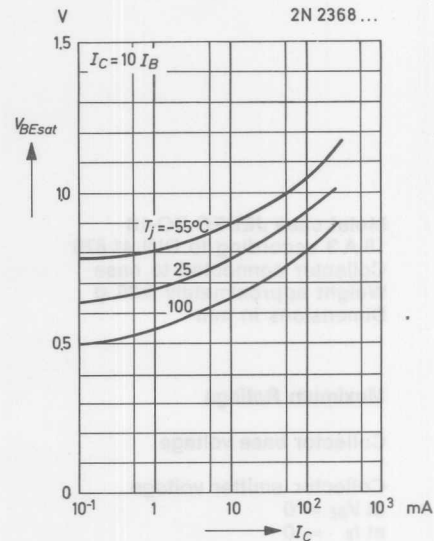
DC current gain versus collector current



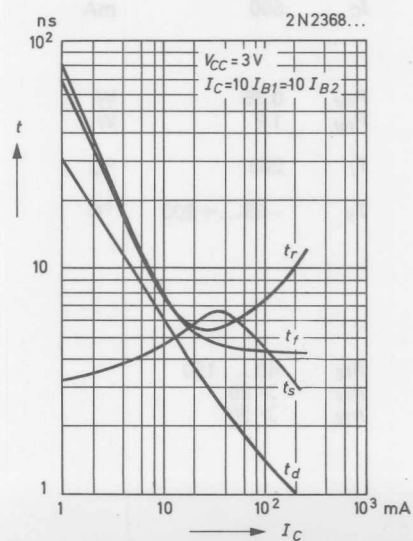
Collector saturation voltage
versus collector current



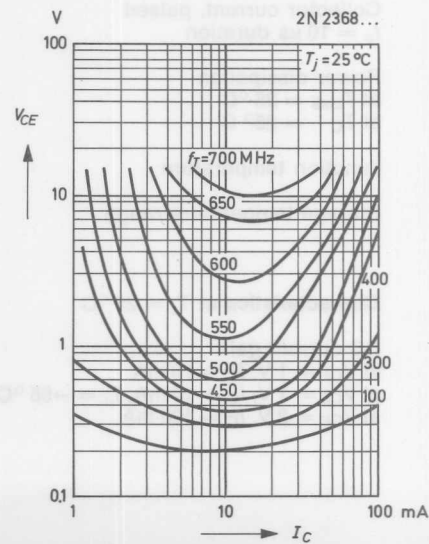
Base saturation voltage
versus collector current



Switching times
versus collector current



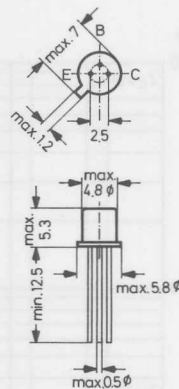
Contours of constant
gain bandwidth product



NPN Silicon Epitaxial Planar Transistor

for switching applications at switching frequencies up to 50 ... 100 MHz
and collector currents from 0.1 to 100 mA.

Metal case JEDEC TO-18
18 A 3 according to DIN 41876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

**Maximum Ratings**

Collector base voltage	V_{CB0}	40	V
Collector emitter voltage	V_{CES}	40	V
at $V_{BE} = 0$	V_{CE0}	15	V
at $I_B = 0$			
Emitter base voltage	V_{EB0}	4.5	V
Collector current	I_C	200	mA
Collector current, pulsed	I_C	500	mA
$t_p = 10 \mu s$ duration			
Power dissipation	P_{tot}	0.36	W
at $T_{amb} = 25^\circ C$	P_{tot}	1.2	W
at $T_C = 25^\circ C$			
Junction temperature	T_j	200	$^\circ C$
Storage temperature range	T_S	-65 ... +200	$^\circ C$

Characteristics at $T_j = 25^\circ C$ **DC current gain**

at $V_{CE} = 1 V, I_C = 10 mA$
at $V_{CE} = 1 V, I_C = 10 mA, T_j = -55^\circ C$
at $V_{CE} = 2 V, I_C = 100 mA$

h_{FE}	40 ... 120
h_{FE}	> 20
h_{FE}	> 20

Collector saturation voltage
at $I_C = 10 \text{ mA}$, $I_B = 1 \text{ mA}$

$V_{CE \text{ sat}}$ 0.2 (< 0.25) V

Base saturation voltage
at $I_C = 10 \text{ mA}$, $I_B = 1 \text{ mA}$

$V_{BE \text{ sat}}$ 0.7 ... 0.85 V

Collector cutoff current
at $V_{CB} = 20 \text{ V}$
at $V_{CB} = 20 \text{ V}$, $T_j = 150^\circ \text{C}$

I_{CB0} < 0.4 μA
 I_{CB0} < 30 μA

Collector base capacitance
at $V_{CB0} = 5 \text{ V}$

C_{CB0} 2.5 (< 4) pF

Gain bandwidth product
at $V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$

f_T > 500 MHz

Storage time constant
at $I_C = I_{B1} = -I_{B2} = 10 \text{ mA}$

τ_s < 13 ns

Turn-on time
at $I_C = 10 \text{ mA}$, $I_{B1} = 3 \text{ mA}$

t_{on} < 12 ns

Turn-off time
at $I_C = 10 \text{ mA}$, $I_{B1} = 3 \text{ mA}$,
 $-I_{B2} = 1.5 \text{ mA}$

t_{off} < 18 ns

Thermal resistance
Junction to ambient air
Junction to case

R_{thA} < 480 $^\circ\text{C/W}$
 R_{thC} < 150 $^\circ\text{C/W}$

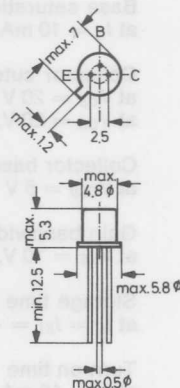
Curves and characteristics of type 2 N 2368 are valid analogously for type 2 N 2369.

2 N 2369 A

NPN Silicon Epitaxial Planar Transistor

for switching applications at switching frequencies up to 50 ... 100 MHz
and collector currents from 0.1 to 100 mA.

Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	40	V
Collector emitter voltage	V_{CES}	40	V
at $V_{BE} = 0$	V_{CEO}	15	V
at $I_B = 0$			
Emitter base voltage	V_{EB0}	4.5	V
Collector current	I_C	200	mA
Collector current, pulsed	I_C	500	mA
$t_p = 10 \mu s$ duration			
Power dissipation	P_{tot}	0.36	W
at $T_{amb} = 25^\circ C$	P_{tot}	1.2	W
at $T_C = 25^\circ C$			
Junction temperature	T_j	200	$^\circ C$
Storage temperature range	T_S	- 65 ... + 200	$^\circ C$

Characteristics at $T_j = 25^\circ C$

DC current gain	h_{FE}	40 ... 120 (66)
at $V_{CE} = 1 V, I_C = 10 mA$	h_{FE}	40 ... 120 (63)
at $V_{CE} = 0.35 V, I_C = 10 mA$	h_{FE}	70 (> 30)
at $V_{CE} = 0.4 V, I_C = 30 mA$	h_{FE}	> 20
at $V_{CE} = 1 V, I_C = 100 mA$	h_{FE}	50 (> 20)
at $V_{CE} = 0.35 V, I_C = 10 mA, T_j = -55^\circ C$	h_{FE}	

Collector saturation voltage

at $I_C = 10 \text{ mA}$, $I_B = 1 \text{ mA}$ at $I_C = 30 \text{ mA}$, $I_B = 3 \text{ mA}$ at $I_C = 100 \text{ mA}$, $I_B = 10 \text{ mA}$ at $I_C = 10 \text{ mA}$, $I_B = 1 \text{ mA}$, $T_j = 125^\circ\text{C}$ $V_{CE \text{ sat}}$ 0.14 (< 0.2) V $V_{CE \text{ sat}}$ 0.17 (< 0.25) V $V_{CE \text{ sat}}$ 0.28 (< 0.5) V $V_{CE \text{ sat}}$ 0.19 (< 0.3) V

Base saturation voltage

at $I_C = 10 \text{ mA}$, $I_B = 1 \text{ mA}$ at $I_C = 30 \text{ mA}$, $I_B = 3 \text{ mA}$ at $I_C = 100 \text{ mA}$, $I_B = 10 \text{ mA}$ $V_{BE \text{ sat}}$ 0.7 ... 0.85 V $V_{BE \text{ sat}}$ 0.9 (< 1.15) V $V_{BE \text{ sat}}$ 1.1 (< 1.6) V

Collector cutoff current

at $V_{CB0} = 20 \text{ V}$, $T_j = 150^\circ\text{C}$ at $V_{CE} = 20 \text{ V}$ I_{CB0} 10 (< 30) μA I_{CES} 50 (< 400) nA

Thermal resistance

Junction to ambient air

Junction to case

 R_{thA} < 480 $^\circ\text{C/W}$ R_{thC} < 150 $^\circ\text{C/W}$ Dynamic characteristics at $T_{amb} = 25^\circ\text{C}$

Gain bandwidth product

at $V_{CE} = 10 \text{ V}$, $I_C = 10 \text{ mA}$, $f = 100 \text{ MHz}$ f_T 675 (> 500) MHz

Collector base capacitance

at $V_{CB0} = 5 \text{ V}$ C_{CB0} 2.3 (< 4) pF

Storage time constant

at $I_C = I_{B1} = -I_{B2} = 10 \text{ mA}$ τ_s 6 (< 13) ns

Turn-on time

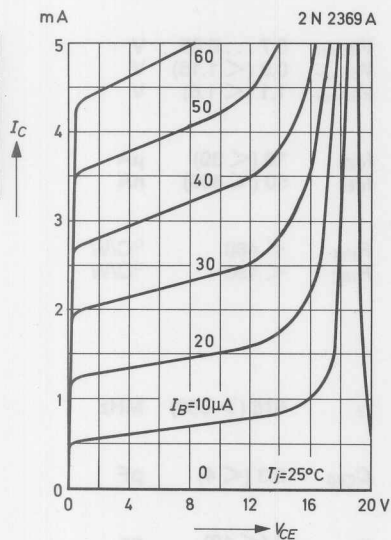
at $I_C = 10 \text{ mA}$, $I_{B1} = 3 \text{ mA}$ t_{on} 9 (< 12) ns

Turn-off time

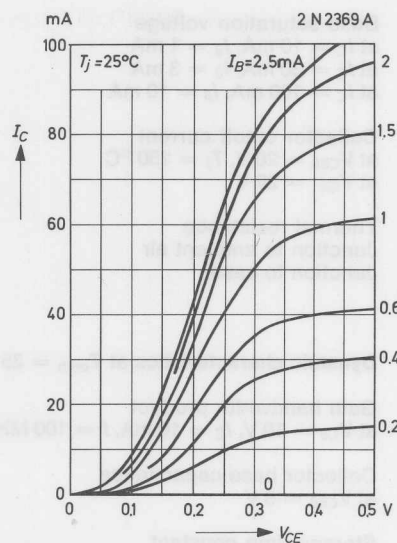
at $I_C = 10 \text{ mA}$, $I_{B1} = 3 \text{ mA}$, $-I_{B2} = 1.5 \text{ mA}$ t_{off} 13 (< 18) ns

2 N 2369 A

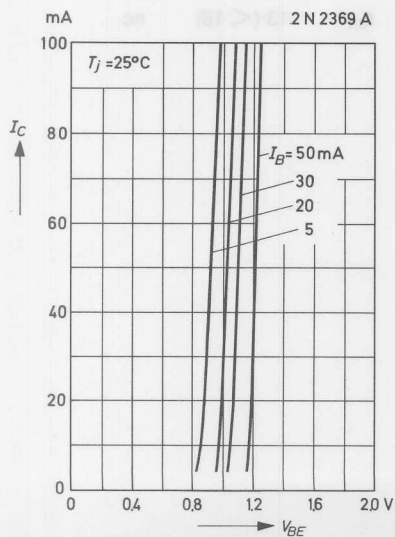
Common emitter collector characteristics



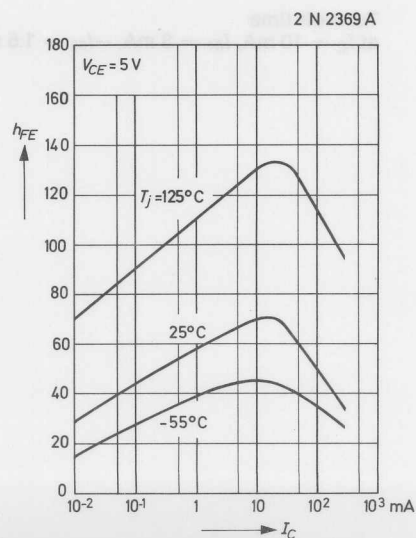
Common emitter collector characteristics



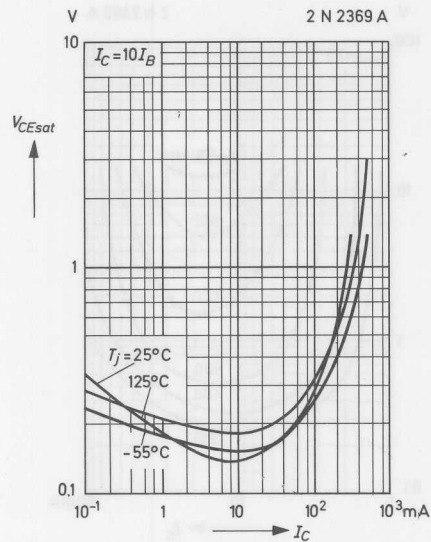
Collector current versus base emitter voltage



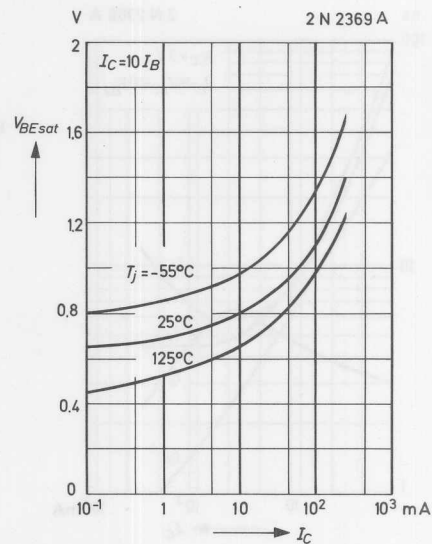
DC current gain versus collector current



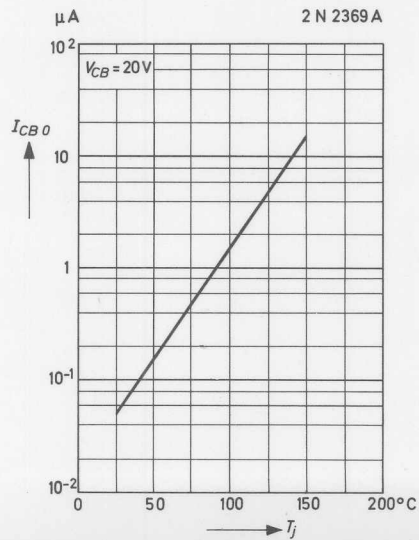
**Collector saturation voltage
versus collector current**



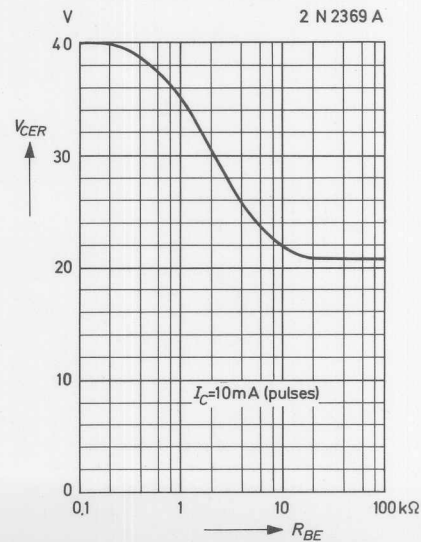
**Base saturation voltage
versus collector current**



**Collector cutoff current
versus junction temperature**

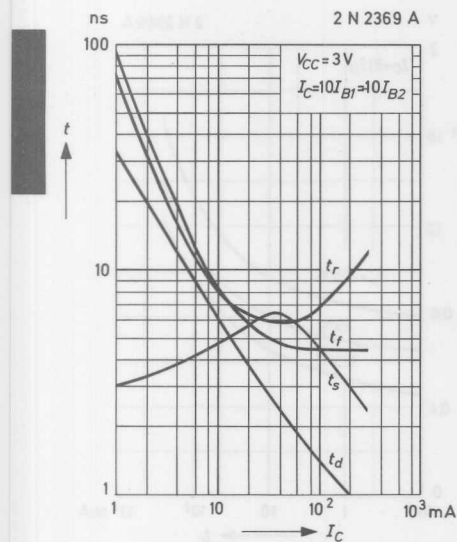


**Admissible collector emitter
voltage versus
base emitter resistance**

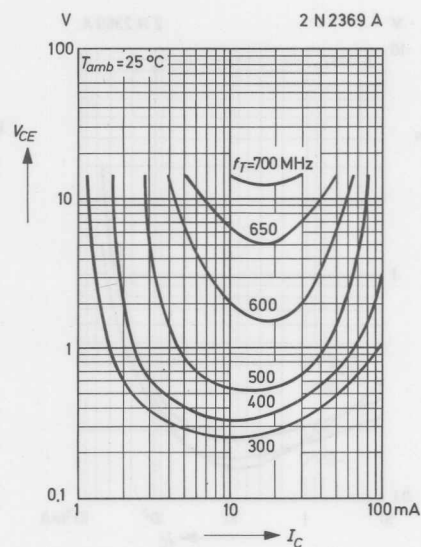


2 N 2369 A

Switching times
versus collector current



Contours of constant
gain bandwidth product







NPN Silicon Epitaxial Power Transistor
with high collector emitter voltage, extending
for use as intermediate amplifier between the first
frequency integrated circuit TAA 100 and the line
output tube in TV sets.



NPN Silicon High Frequency Transistors

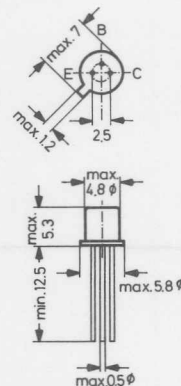
Maximum ratings	
Collector emitter voltage	V_{CE} 50 V
Emitter base voltage	V_{BE} 5 V
Collector current	I_C 0.5 A
Power dissipation	P_{tot} 0.5 W
at $T_{amb} = 25^\circ\text{C}$	
at $T_c = 75^\circ\text{C}$	
Junction temperature	T_j 150 °C
Storage temperature range	T_s -55 ... +125 °C
Characteristics at $T_j = 25^\circ\text{C}$	
DC current gain	β_{DC} 100
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$	
Collector cutoff current	I_{CE0} 10 μA
at $V_{CE} = 10\text{ V}$	
Collector saturation voltage	$V_{CE(sat)}$ 0.5 V
at $I_C = 10\text{ mA}$, $\beta = 50$	
Thermal resistance	$R_{th(j-a)}$ 100 $^\circ\text{C/W}$
Junction to ambient β	
Junction to case	

BF 120

NPN Silicon Epitaxial Planar Transistor

with high collector emitter voltage, intended for use as interstage amplifier between the line frequency integrated circuit TAA 790 and the line output tube in TV sets.

Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm



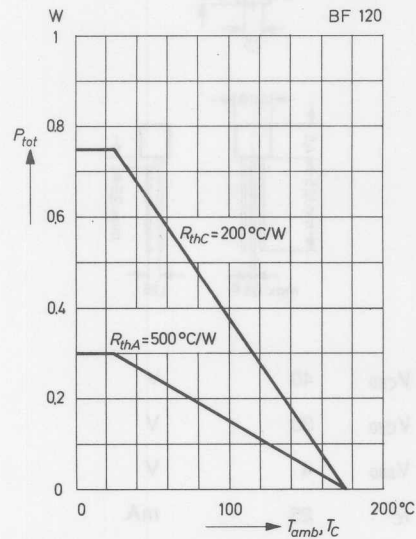
Maximum Ratings

Collector emitter voltage	V_{CE0}	220	V
Emitter base voltage	V_{EB0}	5	V
Collector current	I_C	50	mA
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	300	mW
at $T_C = 25^\circ\text{C}$	P_{tot}	750	mW
Junction temperature	T_j	175	$^\circ\text{C}$
Storage temperature range	T_S	$-55 \dots + 175^\circ\text{C}$	

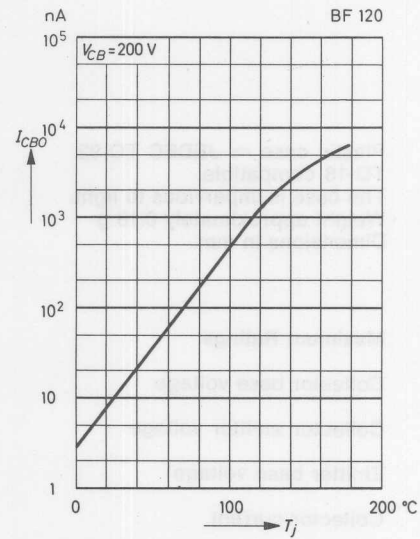
Characteristics at $T_j = 25^\circ\text{C}$

DC current gain	h_{FE}	> 20	
at $V_{CE} = 10\text{ V}$, $I_C = 10\text{ mA}$			
Collector cutoff current	I_{CB0}	10 (< 200)	nA
at $V_{CB} = 200\text{ V}$			
Collector saturation voltage	V_{CEsat}	< 2	V
at $I_C = 10\text{ mA}$, $I_B = 2\text{ mA}$			
Thermal resistance			
Junction to ambient air	R_{thA}	< 500	$^\circ\text{C/W}$
Junction to case	R_{thC}	< 200	$^\circ\text{C/W}$

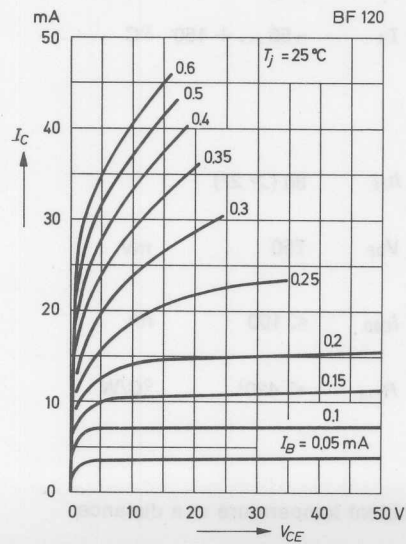
**Admissible power dissipation
versus temperature**



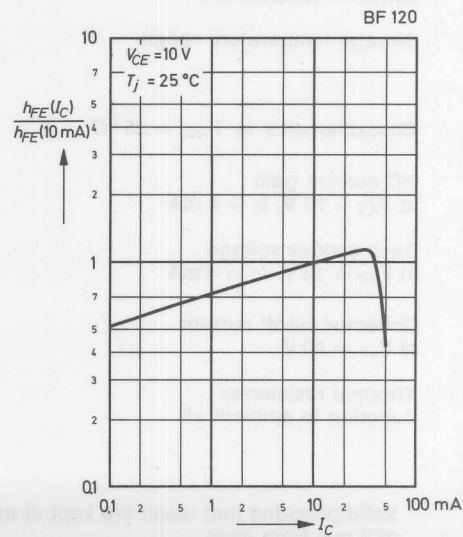
**Collector cutoff current
versus junction temperature**



**Common emitter
collector characteristics**



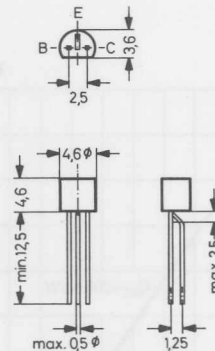
**Relative DC current gain
versus collector current**



NPN Silicon Planar Transistor

designed for RF applications; low feedback capacitance, especially suited for AGC in emitter-grounded IF stages in TV sets.

Plastic case \approx JEDEC TO-92
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

**Maximum Ratings**

Collector base voltage	V_{CB0}	40	V
Collector emitter voltage	V_{CE0}	30	V
Emitter base voltage	V_{EB0}	4	V
Collector current	I_C	25	mA
Base current	I_B	3	mA
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}	300 ¹	mW
Junction temperature	T_j	150	$^\circ\text{C}$
Storage temperature range	T_S	$-55 \dots + 150$	$^\circ\text{C}$

Characteristics at $T_{amb} = 25^\circ\text{C}$

DC current gain at $V_{CE} = 10\text{ V}$, $I_C = 4\text{ mA}$	h_{FE}	80 (> 27)	
Base emitter voltage at $V_{CB} = 10\text{ V}$, $I_C = 4\text{ mA}$	V_{BE}	750	mV
Collector cutoff current at $V_{CB} = 40\text{ V}$	I_{CB0}	< 100	nA
Thermal resistance Junction to ambient air	R_{thA}	< 420 ¹	$^\circ\text{C/W}$

¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

Feedback capacitance
at $V_{CB} = 10\text{ V}$, $I_C = 1\text{ mA}$, $f = 1\text{ MHz}$

$-C_{re}$ 0.22 pF

Gain bandwidth product
at $V_{CB} = 10\text{ V}$, $I_C = 4\text{ mA}$, $f = 100\text{ MHz}$

f_T 400 MHz

Noise figure at $V_{CB} = 10\text{ V}$,
 $I_C = 4\text{ mA}$, $f = 35\text{ MHz}$, $R_G = 100\ \Omega$

F 3 dB

y-Parameters (emitter grounded)
at $f = 35\text{ MHz}$, $V_{CB} = 10\text{ V}$, $I_C = 4\text{ mA}$

Input admittance

g_{ie} 4.5 mmho

Output admittance

g_{oe} 35 μmho

Input capacitance

C_{ie} 40 pF

Output capacitance

C_{oe} 1.3 pF

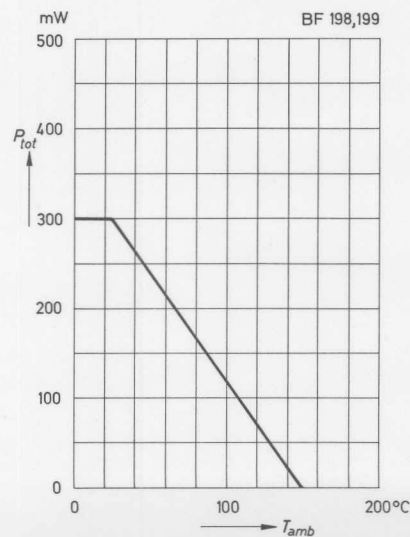
Forward transconductance

$|y_{fe}|$ 105 mmho
 φ_{fe} -20°

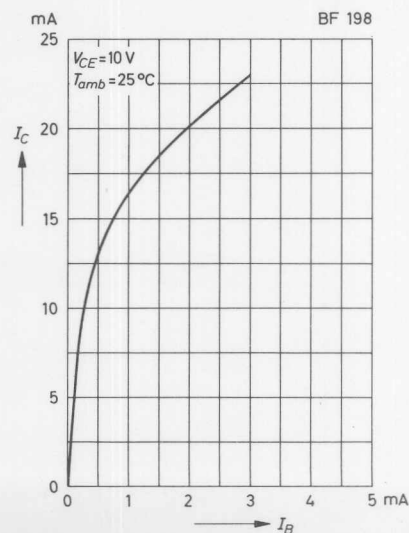
Reverse transconductance

$|y_{re}|$ 45 μmho
 φ_{re} -95°

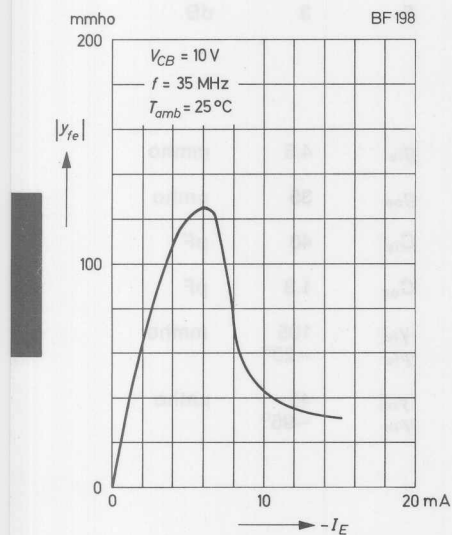
**Admissible power dissipation
versus ambient temperature**
(see note on previous page)



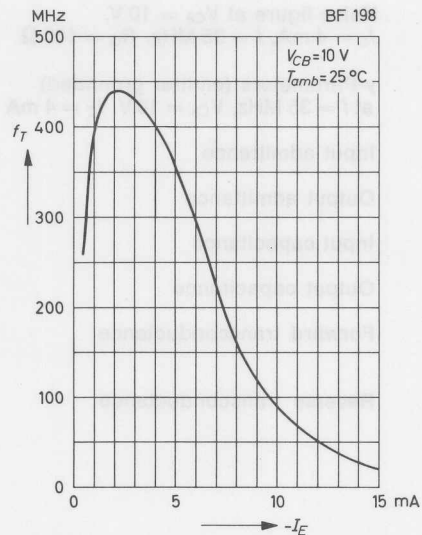
**Collector current
versus base current**



Forward transconductance
versus emitter current



Gain bandwidth product
versus emitter current



BF198 is a silicon NPN transistor designed for RF applications; low junction capacitance, especially suited for emitter-grounded IF stages in TV sets.



Plastic case - JEDEC TO-18
TO-18 compatible
The case is insulating in type
Weight approximately 0.15 g
Dimensions in mm

Maximum Ratings

Collector base voltage	V_{CB}	40	V
Collector emitter voltage	V_{CE}	20	V
Emitter base voltage	V_{EB}	4	V
Collector current	I_C	20	mA
Base current	I_B	5	mA
Power dissipation P_{tot} at $T_{amb} = 25^\circ\text{C}$	P_{tot}	200	mW
Junction temperature	T_j	150	$^\circ\text{C}$
Storage temperature range	T_s	-55 ... +150	$^\circ\text{C}$

Characteristics at $T_{amb} = 25^\circ\text{C}$

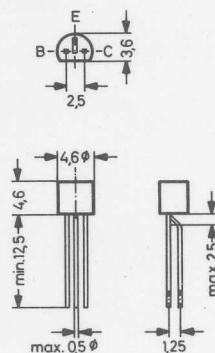
DC current gain	β_{DC}	50 (≥ 30)	
at $V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$			
Base emitter voltage	V_{BE}	750	mV
at $V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$			
Collector cutoff current	I_{CBO}	< 100	nA
at $V_{CE} = 40\text{ V}$			
Thermal resistance	R_{th}	< 450	$^\circ\text{C/W}$
Junction to ambient at			

Values provided in all tests are valid at ambient temperature in a distance of 5 mm from case.

NPN Silicon Epitaxial Planar Transistor

designed for RF applications; low feedback capacitance, especially suited for emitter-grounded IF stages in TV sets.

Plastic case \approx JEDEC TO-92,
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

**Maximum Ratings**

Collector base voltage	V_{CB0}	40	V
Collector emitter voltage	V_{CE0}	25	V
Emitter base voltage	V_{EB0}	4	V
Collector current	I_C	25	mA
Base current	I_B	2	mA
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}	300 ¹	mW
Junction temperature	T_j	150	$^\circ\text{C}$
Storage temperature range	T_S	$-55 \dots +150^\circ\text{C}$	

Characteristics at $T_{amb} = 25^\circ\text{C}$

DC current gain at $V_{CE} = 10\text{ V}$, $I_C = 7\text{ mA}$	h_{FE}	88 (> 38)	
Base emitter voltage at $V_{CB} = 10\text{ V}$, $I_C = 7\text{ mA}$	V_{BE}	750	mV
Collector cutoff current at $V_{CB} = 40\text{ V}$	I_{CB0}	< 100	nA
Thermal resistance Junction to ambient air	R_{thA}	< 420 ¹	$^\circ\text{C/W}$

¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

Feedback capacitance
at $V_{CB} = 10\text{ V}$, $I_C = 1\text{ mA}$, $f = 1\text{ MHz}$

$-C_{re}$ 0.32 pF

Gain bandwidth product
at $V_{CB} = 10\text{ V}$, $I_C = 5\text{ mA}$, $f = 100\text{ MHz}$

f_T 550 MHz

y-Parameters (emitter grounded)
at $f = 35\text{ MHz}$, $V_{CB} = 10\text{ V}$, $I_C = 7\text{ mA}$

Input admittance

g_{ie} 5 mmho

Output admittance

g_{oe} 75 μmho

Input capacitance

C_{ie} 45 pF

Output capacitance

C_{oe} 1.6 pF

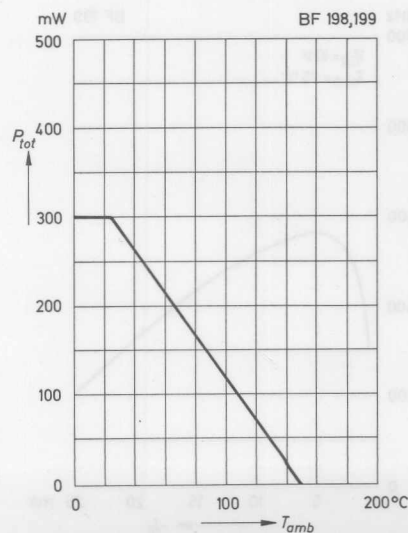
Forward transconductance

$|y_{fe}|$ 175 mmho
 φ_{fe} -25°

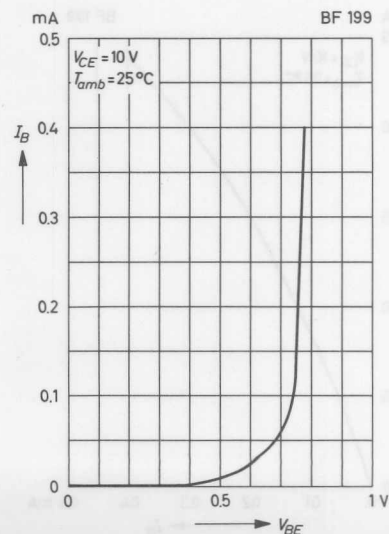
Reverse transconductance

$|y_{re}|$ 65 μmho
 φ_{re} -95°

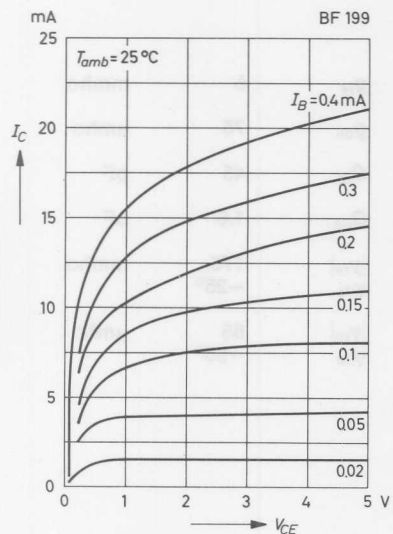
**Admissible power dissipation
versus ambient temperature**
(see note on previous page)



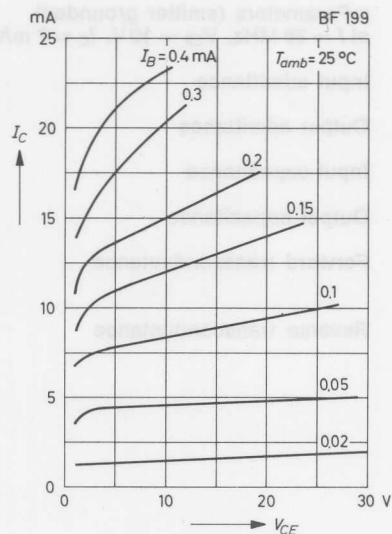
**Common emitter
input characteristic**



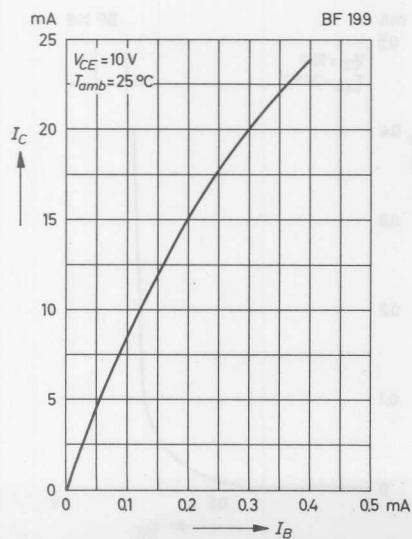
Common emitter collector characteristics



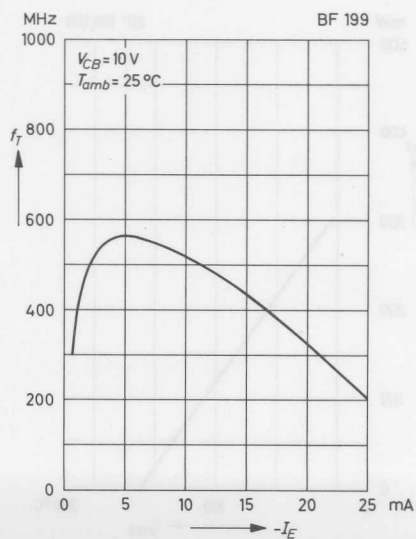
Common emitter collector characteristics



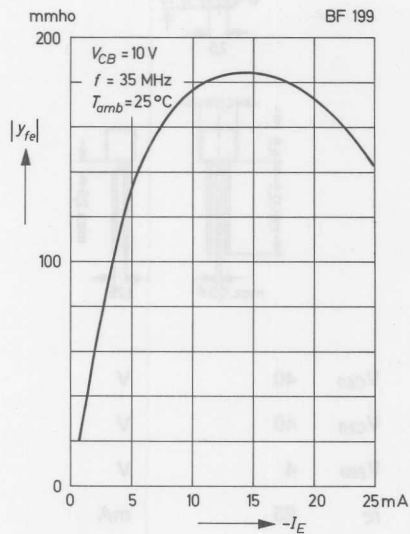
Collector current versus base current



Gain bandwidth product versus emitter current



Forward transconductance versus emitter current



Plastic case - JEDEC TO-18
TYPED component
The case is impervious to light.
Weight approximately 0.16 g
Dimensions in mm

Maximum Ratings

Collector base voltage

Collector emitter voltage

Emitter base voltage

Collector current

Base current

Power dissipation at $T_{amb} = 25^\circ \text{C}$

Junction temperature

Storage temperature range

Characteristics at $T_{amb} = 25^\circ \text{C}$

DC current gain

at $V_{CE} = 10 \text{ V}$, $I_C = 1 \text{ mA}$

BF 199

Base emitter voltage

at $V_{CE} = 10 \text{ V}$, $I_C = 1 \text{ mA}$

Collector cutoff current

at $V_{CE} = 20 \text{ V}$

Thermal resistance

Junction to ambient air

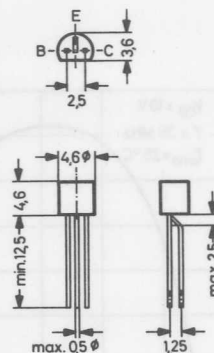
Valid provided that leads are kept at ambient temperature to a distance of 5 mm from case.

BF 240, BF 241

NPN Silicon Epitaxial Planar Transistors

designed for emitter-grounded AM and FM amplifier stages

Plastic case \approx JEDEC TO-92
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm



Maximum Ratings

Collector base voltage	V_{CB0}	40	V
Collector emitter voltage	V_{CE0}	40	V
Emitter base voltage	V_{EB0}	4	V
Collector current	I_C	25	mA
Base current	I_B	2	mA
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}	300 ¹	mW
Junction temperature	T_j	150	$^\circ\text{C}$
Storage temperature range	T_S	$-55 \dots +150$	$^\circ\text{C}$

Characteristics at $T_{amb} = 25^\circ\text{C}$

DC current gain at $V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$	BF 240	h_{FE}	67 ... 220
	BF 241	h_{FE}	36 ... 125
Base emitter voltage at $V_{CB} = 10\text{ V}$, $I_C = 1\text{ mA}$		V_{BE}	700 (650 ... 740) mV
Collector cutoff current at $V_{CB} = 20\text{ V}$		I_{CB0}	< 100 nA
Thermal resistance Junction to ambient air		R_{thA}	< 420 ¹ $^\circ\text{C/W}$

¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

BF 240, BF 241

Collector base breakdown voltage
at $I_C = 10 \mu\text{A}$

$V_{(BR)CB0} > 40$ V

Collector emitter breakdown voltage
at $I_C = 2 \text{ mA}$

$V_{(BR)CE0} > 40$ V

Emitter base breakdown voltage
at $I_E = 10 \mu\text{A}$

$V_{(BR)EB0} > 4$ V

Gain bandwidth product
at $V_{CB} = 10 \text{ V}$, $I_C = 1 \text{ mA}$, $f = 100 \text{ MHz}$

	BF 240	BF 241
f_T	430	400

Feedback capacitance
at $V_{CB} = 10 \text{ V}$, $I_C = 1 \text{ mA}$, $f = 1 \text{ MHz}$

$-C_{re}$ 0.27 pF

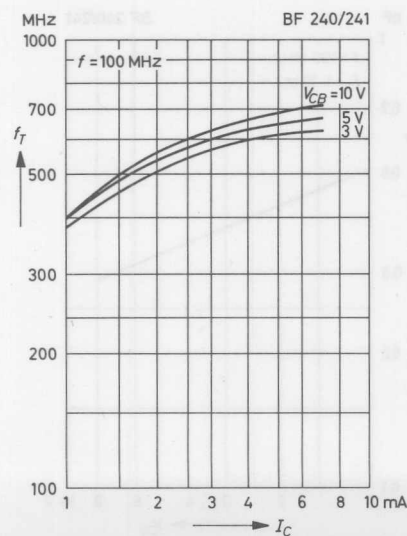
Noise figure (emitter grounded)
at $V_{CB} = 10 \text{ V}$, $I_C = 1 \text{ mA}$
 $g_s = 5 \text{ mmho}$, $f = 200 \text{ kHz}$
 $y_s = (6.6 - j3.3) \text{ mmho}$, $f = 100 \text{ MHz}$

	BF 240	BF 241
F	1.5 (< 3.5)	dB
F	1.6	dB

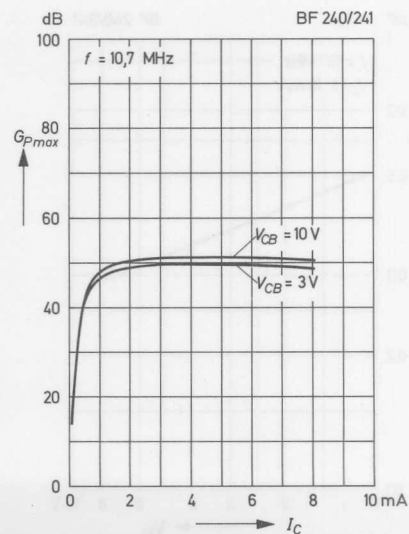
Output admittance
at $V_{CB} = 10 \text{ V}$, $I_C = 1 \text{ mA}$, $f = 10.7 \text{ MHz}$
at $V_{CB} = 10 \text{ V}$, $I_C = 1 \text{ mA}$, $f = 470 \text{ kHz}$

	BF 240	BF 241
g_{oe}	< 10.5	μmho
g_{oe}	< 8.3	μmho

Gain bandwidth product
versus collector current

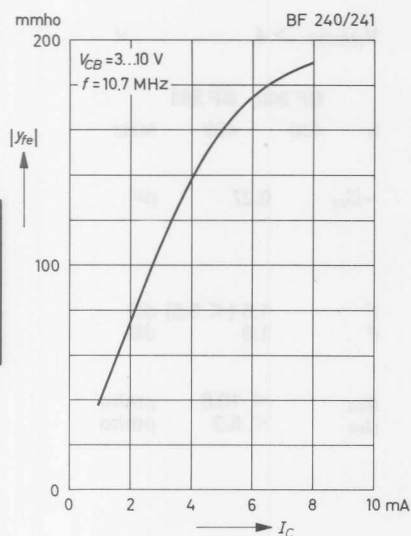


Max. available power gain
versus collector current

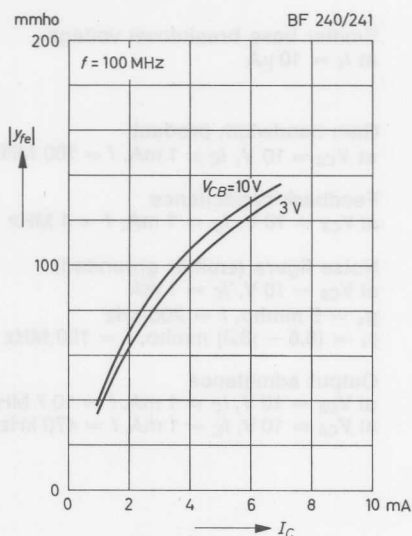


BF 240, BF 241

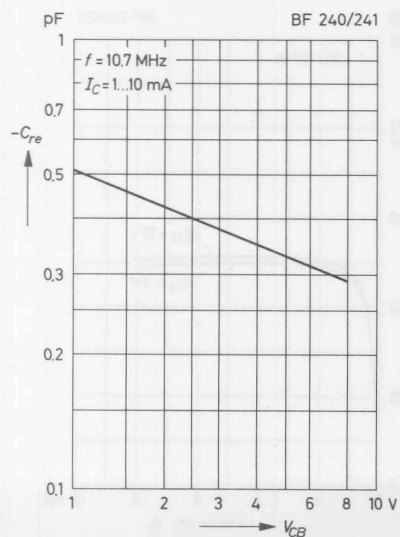
**Forward transconductance
at 10.7 MHz versus
collector current**



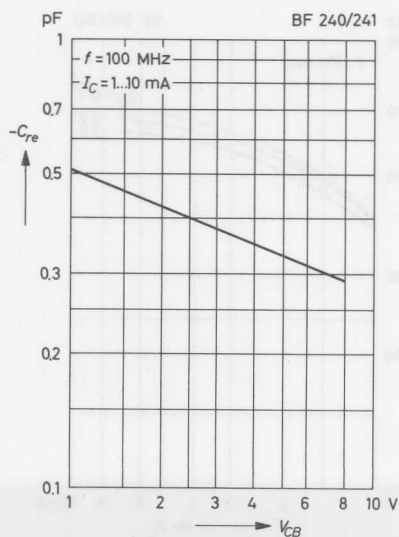
**Forward transconductance
at 100 MHz versus
collector current**



**Feedback capacitance
at 10.7 MHz versus
collector base voltage**

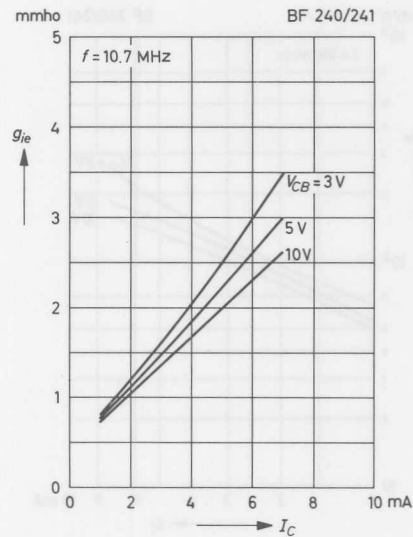


**Feedback capacitance
at 100 MHz versus
collector base voltage**

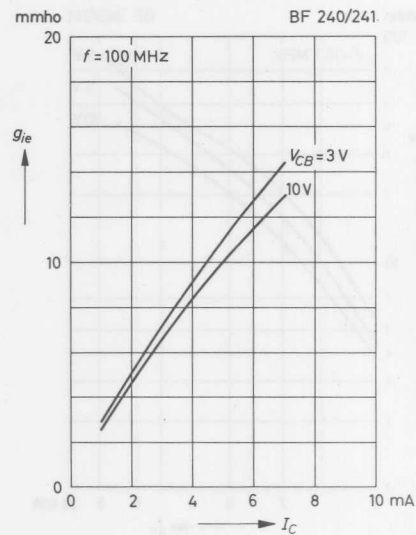


BF 240, BF 241

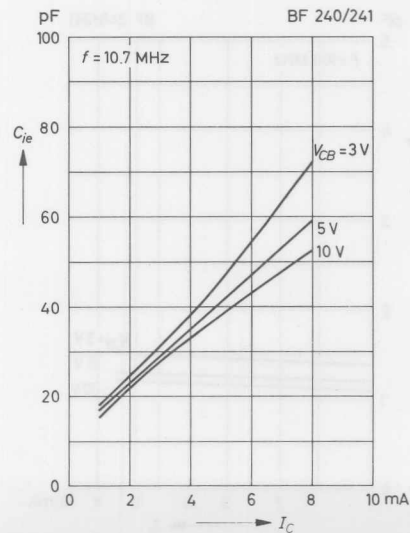
**Input admittance
at 10.7 MHz versus
collector current**



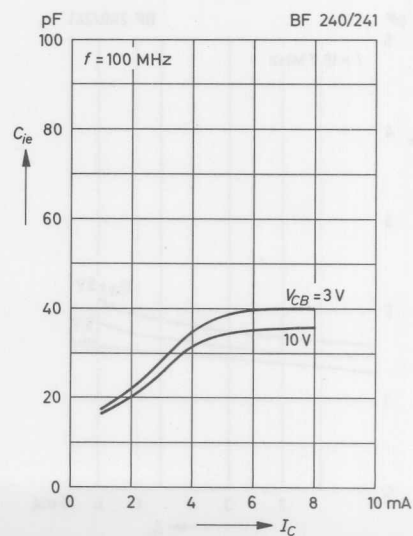
**Input admittance
at 100 MHz versus
collector current**



**Input capacitance
at 10.7 MHz versus
collector current**

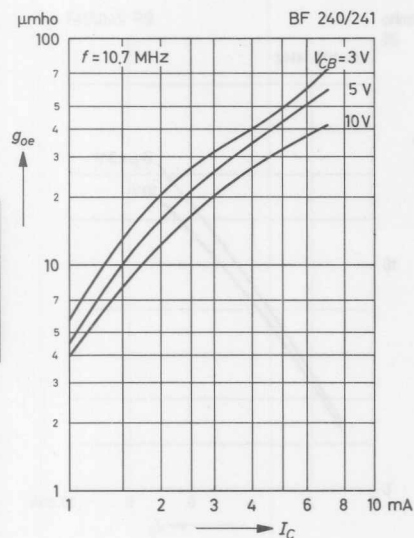


**Input capacitance
at 100 MHz versus
collector current**

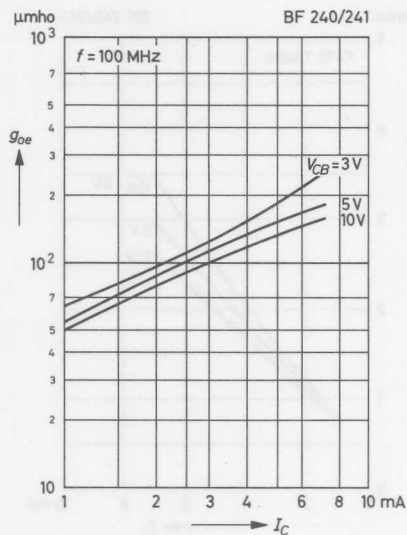


BF 240, BF 241

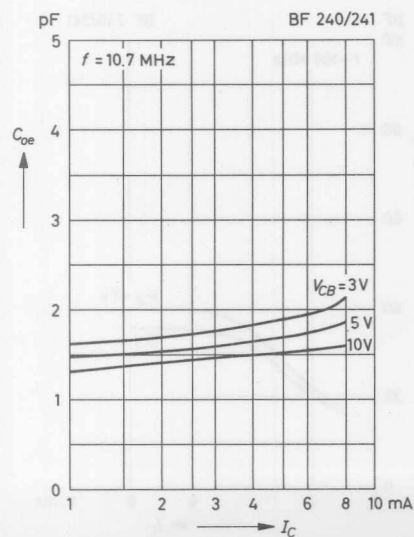
**Output admittance
at 10.7 MHz versus
collector current**



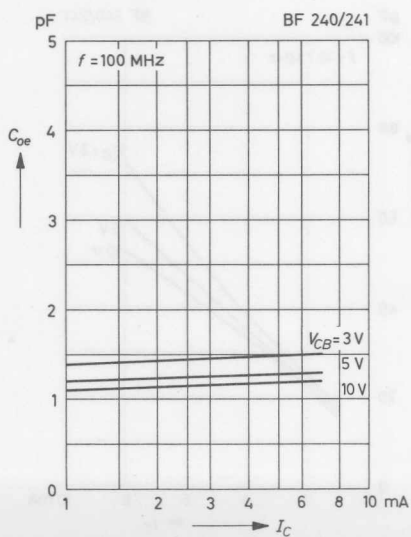
**Output admittance
at 100 MHz versus
collector current**



**Output capacitance
at 10.7 MHz versus
collector current**



**Output capacitance
at 100 MHz versus
collector current**







PNP Silicon Epitaxial Transistors
for switching and amplifier applications

These types are subdivided into three groups: 4-10 and -15, according to their DC current gain. As complementary types the NPN transistors BC 149 and BC 147 are recommended.



Notes: 1. Mounting: TO-18
2. C: according to DIN 41 812
3. Collector connected to case
4. Weight approximately 1 g
5. Dimensions in mm

PNP Silicon Transistors

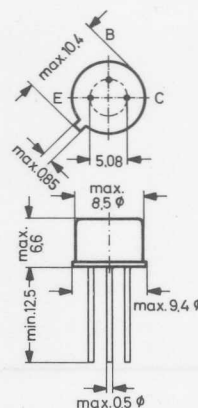
Maximum Ratings		BC 160	BC 161
Collector base voltage	$-V_{CB}$	50	50
Collector emitter voltage	$-V_{CE}$	50	50
Emitter base voltage	$-V_{EB}$	5	5
Collector current	$-I_C$	1	1
Base current	$-I_B$	0.1	0.1
Power dissipation	P_D	0.35	0.35
$T_{amb} = 25^\circ\text{C}$	P_{D1}	0.35	0.35
$T_C = 25^\circ\text{C} - 75^\circ\text{C}$	P_{D2}	0.35	0.35
Junction temperature	T_J	175	175
Storage temperature range	T_S	$-55 \dots +175$	$-55 \dots +175$
Characteristics at $T_J = 25^\circ\text{C}$		BC 160-4 BC 160-15 BC 161-15	BC 161-4 BC 161-15 BC 161-15
DC current gain			
$h_{FE} = 10, -I_C = 0.1 \text{ mA}$	h_{FE}	50	50
$h_{FE} = 10, -I_C = 100 \text{ mA}$	h_{FE}	50	50
$h_{FE} = 10, -I_C = 1 \text{ A}$	h_{FE}	10	10
Collector saturation voltage	$-V_{CE(sat)}$	0.8 (< 1)	0.8 (< 1)
Base emitter voltage	$-V_{BE}$	1.0 (< 1.3)	1.0 (< 1.3)

BC 160, BC 161

PNP Silicon Epitaxial Planar Transistors for switching and amplifier applications

These types are subdivided into three groups, -6, -10 and -16, according to their DC current gain. As complementary types the NPN transistors BC 140 and BC 141 are recommended.

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings		BC 160	BC 161	
Collector base voltage	$-V_{CB0}$	40	60	V
Collector emitter voltage	$-V_{CE0}$	40	60	V
Emitter base voltage	$-V_{EB0}$	5	5	V
Collector current	$-I_C$	1		A
Base current	$-I_B$	0.1		A
Power dissipation				
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.75		W
at $T_C = 60^\circ\text{C}$, $-V_{CE} < 8\text{ V}$	P_{tot}	3.2		W
Junction temperature	T_j	175		$^\circ\text{C}$
Storage temperature range	T_S	-55...+175		$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $-V_{CE} = 1\text{ V}$, $-I_C = 0.1\text{ mA}$
at $-V_{CE} = 1\text{ V}$, $-I_C = 100\text{ mA}$

at $-V_{CE} = 1\text{ V}$, $-I_C = 1\text{ A}$

Collector saturation voltage
at $-I_C = 1\text{ A}$, $-I_B = 100\text{ mA}$

Base emitter voltage
at $-V_{CE} = 1\text{ V}$, $-I_C = 1\text{ A}$

	BC 160-6	BC 160-10	BC 160-16
	BC 161-6	BC 161-10	BC 161-16
h_{FE}	46	80	120
h_{FE}	63	100	160
	(40...100)	(63...160)	(100...250)
h_{FE}	15	20	30
$-V_{CE\ sat}$	0.6 (< 1)		V
$-V_{BE}$	1.0 (< 1.7)		V

BC 160, BC 161

Collector cutoff current

at $-V_{CE} = 40$ V
 at $-V_{CE} = 60$ V
 at $-V_{CE} = 40$ V, $T_j = 150$ °C
 at $-V_{CE} = 60$ V, $T_j = 150$ °C

	BC 160	BC 161
$-I_{CES}$	10 (< 100)	—
$-I_{CES}$	—	10 (< 100)
$-I_{CES}$	10 (< 100)	—
$-I_{CES}$	—	10 (< 100)

Collector emitter breakdown voltage

at $-I_C = 0.1$ mA
 at $-I_C = 50$ mA (pulsed 200 μ s, 1%)

$-V_{(BR)CES}$	> 40	> 60	V
$-V_{(BR)CEO}$	> 40	> 60	V

Emitter base breakdown voltage

at $-I_C = 0.1$ mA

$-V_{(BR)EBO}$	> 5	> 5	V
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Gain bandwidth product

at $-V_{CE} = 10$ V, $-I_C = 50$ mA,
 $f = 20$ MHz

f_T	> 50	MHz
-------	------	-----

Collector base capacitance

at $-V_{CB0} = 10$ V, $f = 1$ MHz

C_{CB0}	< 30	pF
-----------	------	----

Emitter base capacitance

at $-V_{EB0} = 0.5$ V, $f = 1$ MHz

C_{EB0}	< 180	pF
-----------	-------	----

Thermal resistance

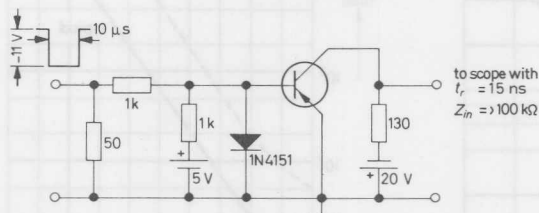
Junction to case
 Junction to ambient air

R_{thC}	< 35	°C/W
R_{thA}	< 200	°C/W

Switching Times at $-I_C = 100$ mA, $-I_{B1} \approx I_{B2} \approx 5$ mA

Turn-on time	t_{on}	< 500	ns
Turn-off time	t_{off}	< 650	ns

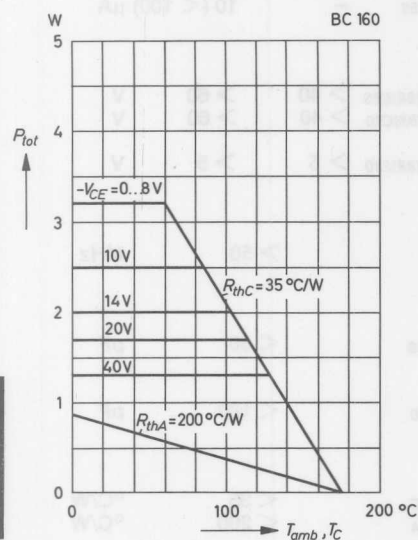
Test Circuit for Switching Times



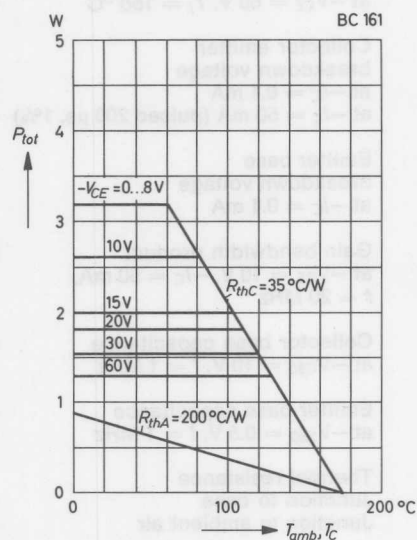
Rise time and fall time of input voltage < 15 ns,
 generator impedance 50 Ω .

BC 160, BC 161

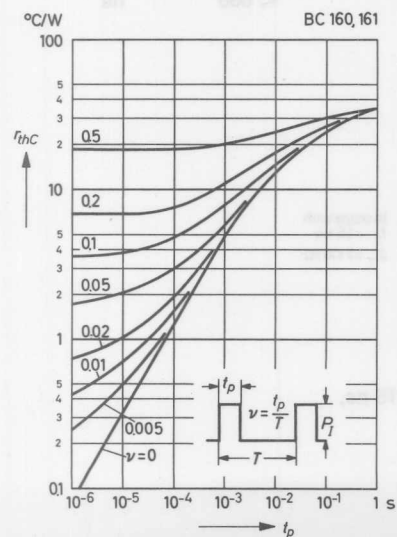
Admissible power dissipation
versus temperature



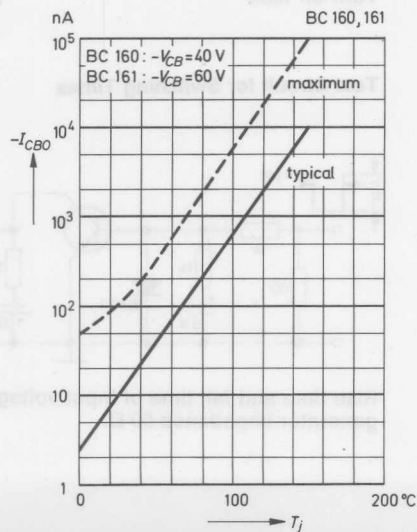
Admissible power dissipation
versus temperature



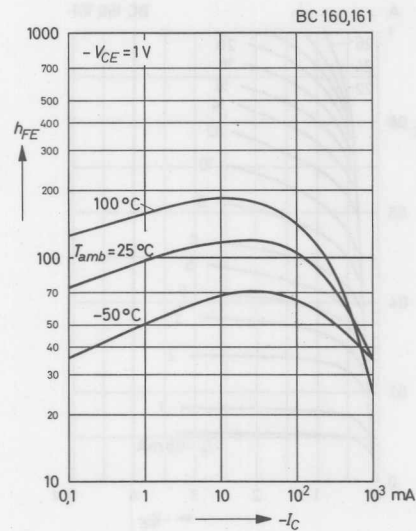
Pulse thermal resistance
versus pulse duration



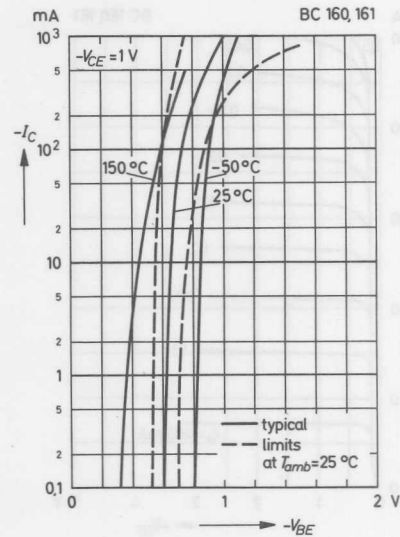
Collector cutoff current
versus junction temperature



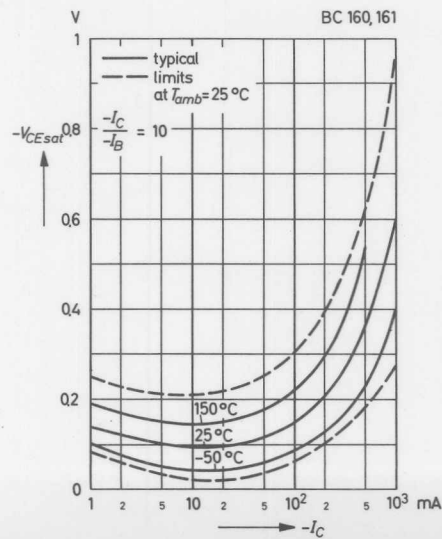
**DC current gain
versus collector current**



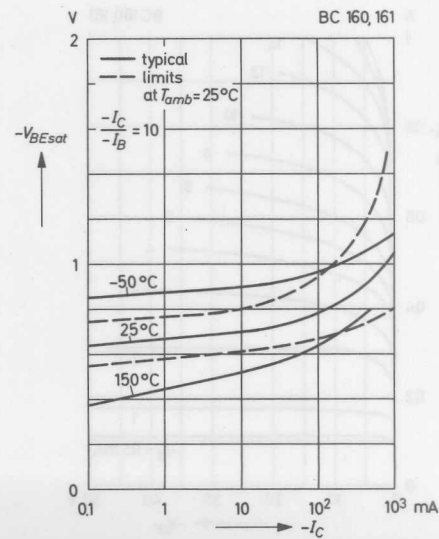
**Collector current
versus base emitter voltage**



**Collector saturation voltage
versus collector current**

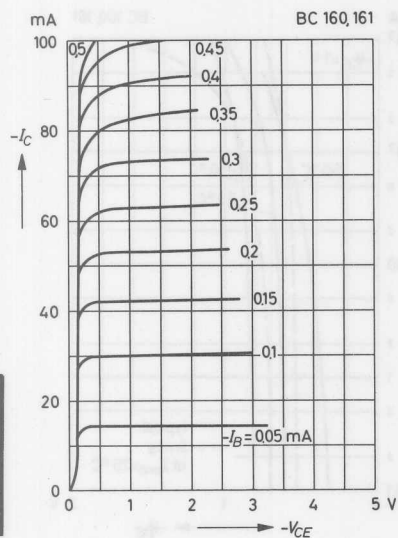


**Base saturation voltage
versus collector current**

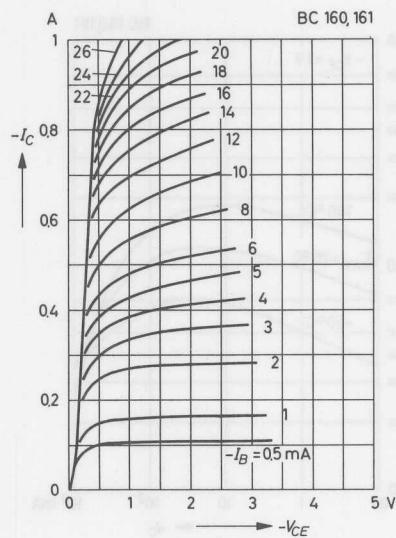


BC 160, BC 161

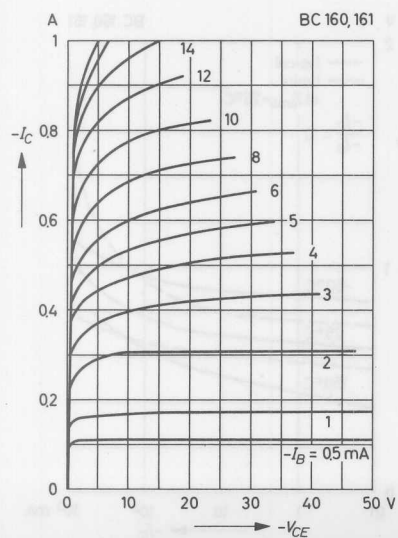
Common emitter
collector characteristics



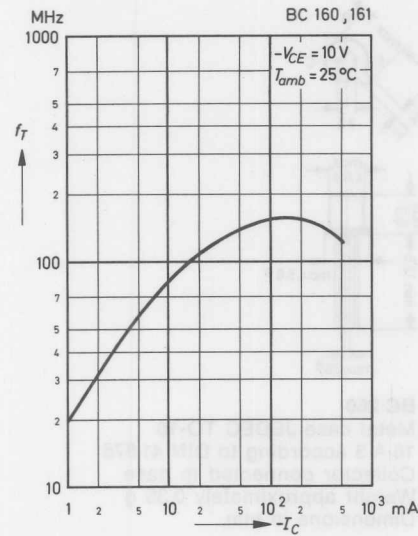
Common emitter
collector characteristics



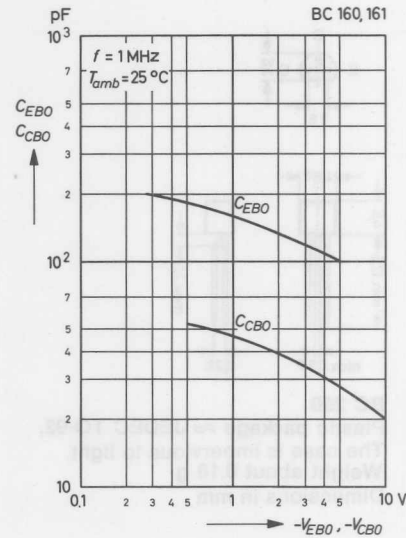
Common emitter
collector characteristics



Gain bandwidth product
versus collector current



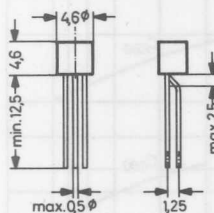
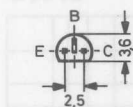
Collector base capacitance,
Emitter base capacitance
versus reverse bias voltage



BC 250, BC 260

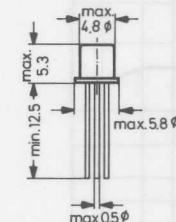
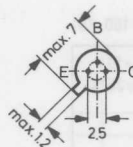
PNP Silicon Epitaxial Planar Transistors for switching and amplifier applications

The transistors are subdivided into three groups A, B and C according to their DC current gain.



BC 250

Plastic package \approx JEDEC TO-92,
The case is impervious to light.
Weight about 0.18 g
Dimensions in mm



BC 260

Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

Maximum Ratings

Collector base voltage	$-V_{CB0}$	20	V
Collector emitter voltage	$-V_{CE0}$	20	V
Emitter base voltage	$-U_{EB0}$	5	V
Collector current	$-I_C$	100	mA

		BC 250	BC 260	
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}	300 ¹	300	mW
Junction temperature	T_j	150	175	$^\circ\text{C}$
Storage temperature range	T_s	$-55 \dots +150$	$-55 \dots +175$	$^\circ\text{C}$

¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

BC 250, BC 260

Characteristics at $T_i = 25^\circ\text{C}$

DC current gain
at $-V_{CE} = 1\text{ V}$, $-I_C = 1\text{ mA}$

Collector saturation voltage
at $-I_C = 30\text{ mA}$, $-I_B = 3\text{ mA}$

Collector cutoff current
at $-V_{CB} = 15\text{ V}$

Emitter cutoff current
at $-V_{EB} = 4\text{ V}$

Gain bandwidth product
at $-V_{CE} = 5\text{ V}$, $-I_C = 10\text{ mA}$,
 $f = 100\text{ MHz}$

Collector base capacitance
at $-V_{CB0} = 10\text{ V}$, $f = 1\text{ MHz}$

Emitter base capacitance
at $-V_{EB0} = 0.5\text{ V}$, $f = 1\text{ MHz}$

Thermal resistance
Junction to ambient air
Junction to case

h_{FE}

BC 250 A	BC 250 B	BC 250 C
BC 260 A	BC 260 B	BC 260 C
35...100	80...250	200...600

$-V_{CE\text{ sat}}$ 0.4

V

$-I_{CB0}$ < 100

nA

$-I_{EB0}$ < 100

nA

f_T 180

MHz

C_{CB0} 3

pF

C_{EB0} 12

pF

BC 250 BC 260

R_{thA}
 R_{thC}

< 420¹

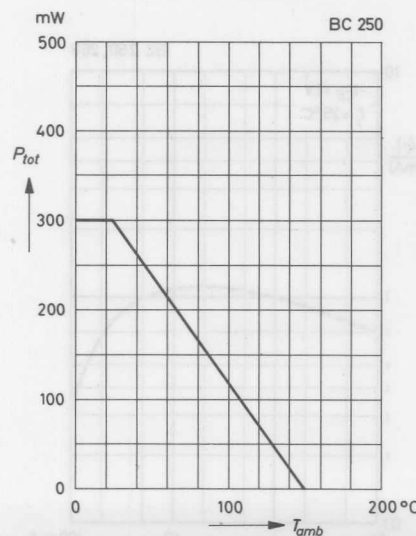
< 500

< 200

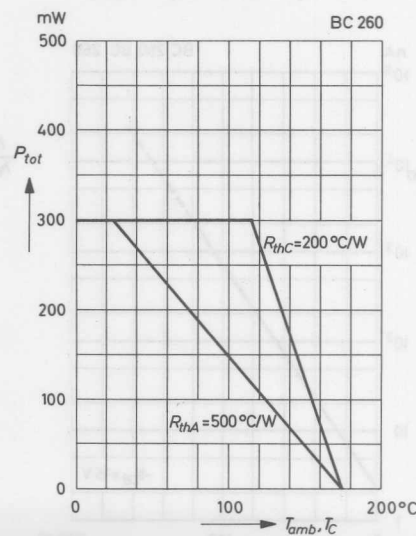
$^\circ\text{C/W}$

$^\circ\text{C/W}$

Admissible power dissipation versus ambient temperature¹



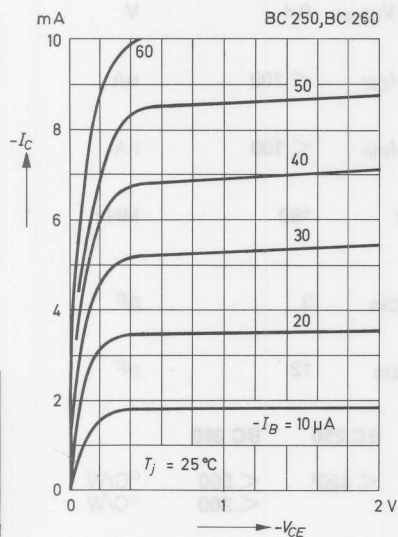
Admissible power dissipation versus temperature



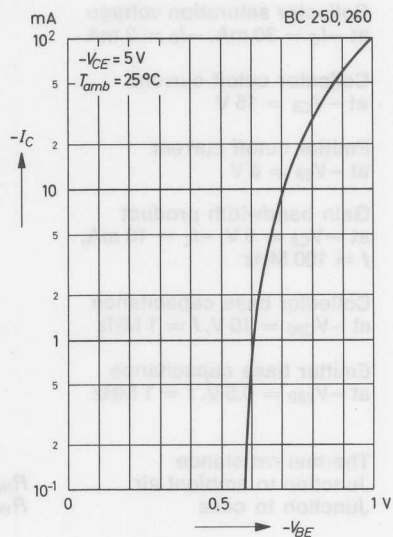
¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

BC 250, BC 260

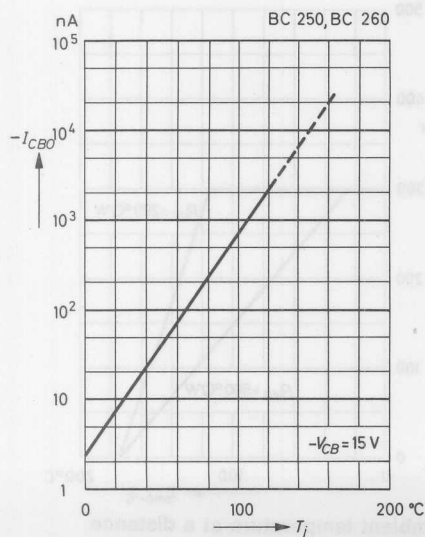
Common emitter
collector characteristics



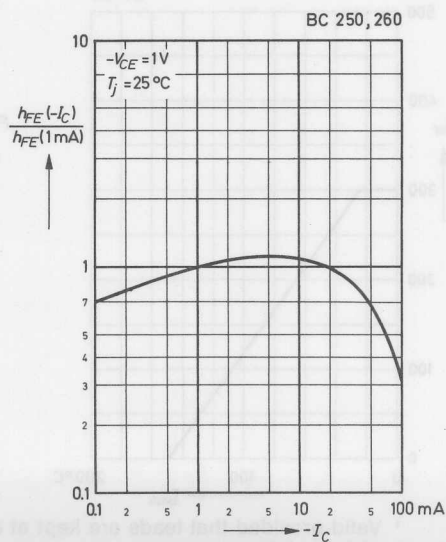
Collector current versus
base emitter voltage



Collector cutoff current
versus junction temperature



Relative DC current gain
versus collector current



BC 250, BC 260

The transistors are subdivided into three groups A, B and C according to their current gain. BC 250 and BC 260 are available in groups A and B only. BC 250, BC 252 and BC 260 are low noise types.

18W Silicon Epitaxial Power Transistors
for switching and amplifier applications



BC 251, BC 253, BC 259, BC 261, BC 263, BC 269

BC 251, BC 253, BC 259, BC 261, BC 263, BC 269

Weight: approximately 0.25 g
Collector connected to case
is A 7 according to DIN 41812
Metal case JEDC TO-18
Dimensions in mm

Weight: approximately 0.25 g
The case is insensitive to light
TO-18 compatible
Dimensions in mm

BC 251, BC 253, BC 259, BC 261, BC 263, BC 269
BC 251, BC 253, BC 259, BC 261, BC 263, BC 269
BC 251, BC 253, BC 259, BC 261, BC 263, BC 269
BC 251, BC 253, BC 259, BC 261, BC 263, BC 269

BC 251	BC 253	BC 259	BC 261	BC 263	BC 269
30	30	30	30	30	30
40	40	40	40	40	40
50	50	50	50	50	50
100	100	100	100	100	100
200	200	200	200	200	200
300	300	300	300	300	300
400	400	400	400	400	400
500	500	500	500	500	500
600	600	600	600	600	600
700	700	700	700	700	700
800	800	800	800	800	800
900	900	900	900	900	900
1000	1000	1000	1000	1000	1000
1100	1100	1100	1100	1100	1100
1200	1200	1200	1200	1200	1200
1300	1300	1300	1300	1300	1300
1400	1400	1400	1400	1400	1400
1500	1500	1500	1500	1500	1500
1600	1600	1600	1600	1600	1600
1700	1700	1700	1700	1700	1700
1800	1800	1800	1800	1800	1800
1900	1900	1900	1900	1900	1900
2000	2000	2000	2000	2000	2000

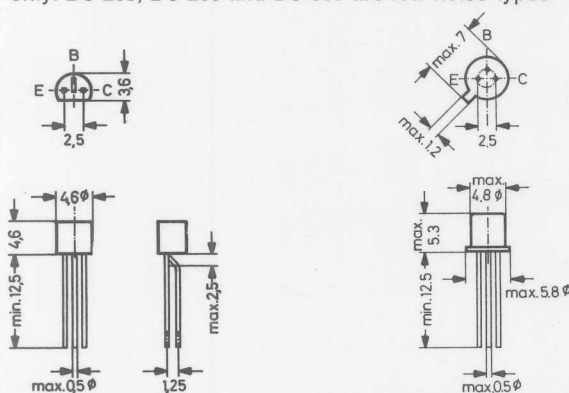
BC 251	BC 253	BC 259	BC 261	BC 263	BC 269
30	30	30	30	30	30
40	40	40	40	40	40
50	50	50	50	50	50
100	100	100	100	100	100
200	200	200	200	200	200
300	300	300	300	300	300
400	400	400	400	400	400
500	500	500	500	500	500
600	600	600	600	600	600
700	700	700	700	700	700
800	800	800	800	800	800
900	900	900	900	900	900
1000	1000	1000	1000	1000	1000
1100	1100	1100	1100	1100	1100
1200	1200	1200	1200	1200	1200
1300	1300	1300	1300	1300	1300
1400	1400	1400	1400	1400	1400
1500	1500	1500	1500	1500	1500
1600	1600	1600	1600	1600	1600
1700	1700	1700	1700	1700	1700
1800	1800	1800	1800	1800	1800
1900	1900	1900	1900	1900	1900
2000	2000	2000	2000	2000	2000

Valid provided that both are kept at ambient temperature of 25°C
at 1 min time base

BC 251..., BC 261..., BC 307 ...

PNP Silicon Epitaxial Planar Transistors for switching and amplifier applications

The transistors are subdivided into three groups A, B and C according to their current gain. BC 256 and BC 266 are available in groups A and B only. BC 253, BC 263 and BC 309 are low noise types.



**BC 251, BC 252, BC 253, BC 256,
BC 307, BC 308, BC 309**

Plastic package \approx JEDEC TO-92,
TO-18 compatible.

The case is impervious to light
Weight approximately 0.18 g
Dimensions in mm

BC 261, BC 262, BC 263, BC 266

Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

BC 251	BC 252	BC 256
BC 261	BC 253	BC 266
BC 307	BC 262	
	BC 263	
	BC 308	
	BC 309	

Maximum Ratings

Collector emitter voltage	$-V_{CES}$	50	30	64	V
Collector emitter voltage	$-V_{CEO}$	45	25	64	V
Emitter base voltage	$-V_{EBO}$	5	5	5	V
Collector current	$-I_C$	100	100	100	mA
Peak collector current	$-I_{CM}$	200	200	200	mA
Base current	$-I_B$	50	50	50	mA
Base peak current	$-I_{BM}$	100	100	100	mA

		TO-92	TO-18	
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}	300 ¹	300	mW
Junction temperature	T_j	150	175	$^\circ\text{C}$
Storage temperature range	T_S	-55...+150	-55...+175	$^\circ\text{C}$

¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

BC 251..., BC 261..., BC 307 ...

Characteristics at $T_{amb} = 25^\circ\text{C}$

h -Parameters at $-V_{CE} = 5\text{ V}$,
 $-I_C = 2\text{ mA}$, $f = 1\text{ kHz}$

Current gain group

		A	B	C	
Small signal current gain	h_{fe}	220 (125..260)	330 (240..500)	600 (450..900)	
Input impedance	h_{ie}	2.7 (1.6..4.5)	4.5 (3.2...8.5)	8.7 (6...15)	k Ω
Output admittance	h_{oe}	18 (< 30)	35 (< 60)	60 (< 110)	μmho
Reverse voltage transfer ratio	h_{re}	$1.5 \cdot 10^{-4}$	$2 \cdot 10^{-4}$	$3 \cdot 10^{-4}$	
DC current gain					
at $-V_{CE} = 5\text{ V}$, $-I_C = 0.01\text{ mA}$	h_{FE}	90	150	270	
at $-V_{CE} = 5\text{ V}$, $-I_C = 2\text{ mA}$	h_{FE}	170	290	500	
at $-V_{CE} = 5\text{ V}$, $-I_C = 100\text{ mA}$	h_{FE}	120 ¹	200 ¹	400 ¹	
Collector saturation voltage					
at $-I_C = 10\text{ mA}$, $-I_B = 0.5\text{ mA}$	$-V_{CE\text{ sat}}$		< 0.3	V	
at $-I_C = 100\text{ mA}$, $-I_B = 5\text{ mA}$	$-V_{CE\text{ sat}}$		0.5 ¹	V	
Base saturation voltage					
at $-I_C = 10\text{ mA}$, $-I_B = 0.5\text{ mA}$	$-V_{BE\text{ sat}}$		0.7	V	
at $-I_C = 100\text{ mA}$, $-I_B = 5\text{ mA}$	$-V_{BE\text{ sat}}$		0.85 ¹	V	
Base emitter voltage					
at $-V_{CE} = 5\text{ V}$, $-I_C = 0.1\text{ mA}$	$-V_{BE}$		0.57	V	
at $-V_{CE} = 5\text{ V}$, $-I_C = 2\text{ mA}$	$-V_{BE}$		0.62	V	
			(0.55...0.7)		
at $-V_{CE} = 5\text{ V}$, $-I_C = 100\text{ mA}$	$-V_{BE}$		0.8	V	

BC 252 BC 251 BC 256
 BC 253 BC 261 BC 266
 BC 262 BC 307
 BC 263
 BC 308
 BC 309

Collector cutoff current

at $-V_{CE} = 25\text{ V}$	$-I_{CES}$	2 (< 15)	—	—	nA
at $-V_{CE} = 45\text{ V}$	$-I_{CES}$	—	2 (< 15)	—	nA
at $-V_{CE} = 64\text{ V}$	$-I_{CES}$	—	—	2 (< 15)	nA
at $-V_{CE} = 25\text{ V}$, $T_i = 125^\circ\text{C}$	$-I_{CES}$	< 4	—	—	μA
at $-V_{CE} = 45\text{ V}$, $T_i = 125^\circ\text{C}$	$-I_{CES}$	—	< 4	—	μA
at $-V_{CE} = 64\text{ V}$, $T_i = 125^\circ\text{C}$	$-I_{CES}$	—	—	< 4	μA

Collector emitter breakdown voltage

at $-I_{CES} = 10\text{ }\mu\text{A}$	$-V_{(BR)CES}$	> 30	> 50	> 64	V
at $-I_{CEO} = 2\text{ mA}$	$-V_{(BR)CEO}$	> 25	> 45	> 64	V

Emitter base breakdown voltage at $-I_{EBO} = 10\text{ }\mu\text{A}$

$-V_{(BR)EBO}$	> 5	> 5	> 5	V
----------------	-----	-----	-----	---

¹ not valid for BC 253, BC 263 and BC 309

BC 251..., BC 261..., BC 307 ...

Gain bandwidth product
at $-V_{CE} = 5 \text{ V}$, $-I_C = 10 \text{ mA}$,
 $f = 50 \text{ MHz}$

f_T 130 MHz

Collector base capacitance
at $-V_{CB0} = 10 \text{ V}$, $f = 1 \text{ MHz}$

C_{CB0} < 6 pF

Emitter base capacitance
at $-V_{EB0} = 0.5 \text{ V}$, $f = 1 \text{ MHz}$

C_{EB0} 12 pF

BC 251, BC 252, BC 256, BC 261, BC 262, BC 266, BC 307, BC 308:

Noise figure
at $-V_{CE} = 5 \text{ V}$, $-I_C = 0.2 \text{ mA}$,
 $R_G = 2 \text{ k}\Omega$, $f = 1 \text{ kHz}$

F < 10 dB

BC 253, BC 263 and BC 309:

Noise figure
at $-V_{CE} = 5 \text{ V}$, $-I_C = 0.2 \text{ mA}$,
 $R_G = 2 \text{ k}\Omega$, $f = 1 \text{ kHz}$

F < 4 dB

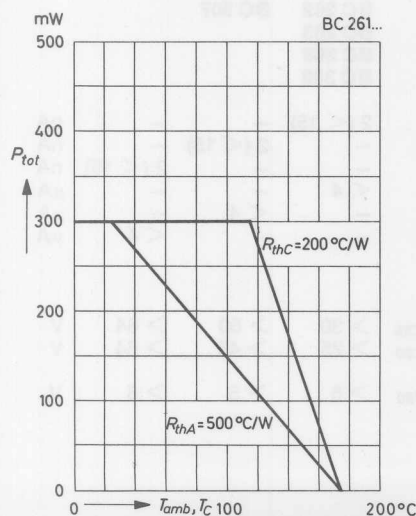
Noise figure
at $-V_{CE} = 5 \text{ V}$, $-I_C = 0.2 \text{ mA}$,
 $R_G = 2 \text{ k}\Omega$, $f = 30 \text{ Hz} \dots 15 \text{ kHz}$

F 2 (< 4) dB

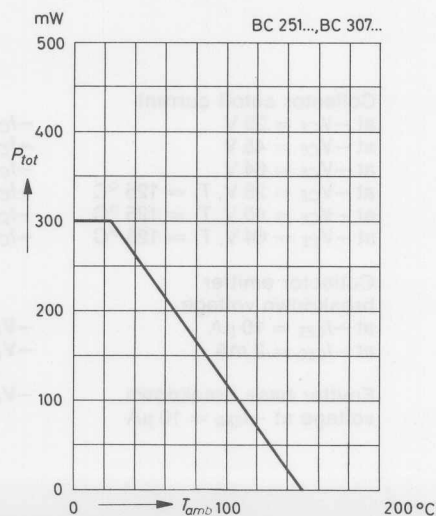
Thermal resistance
Junction to case
Junction to ambient air

	TO-92	TO-18
R_{thC}	—	< 200 °C/W
R_{thA}	< 420 ¹	< 500 °C/W

Admissible power dissipation versus temperature



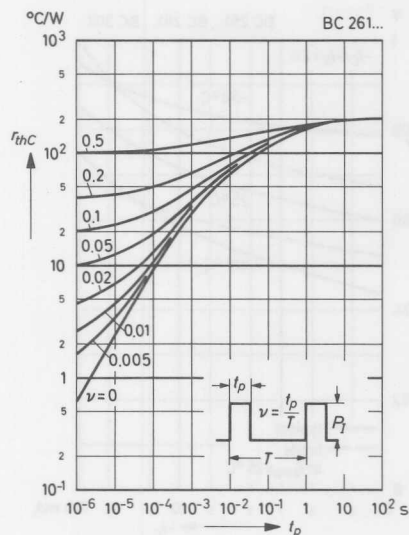
Admissible power dissipation versus ambient temperature¹



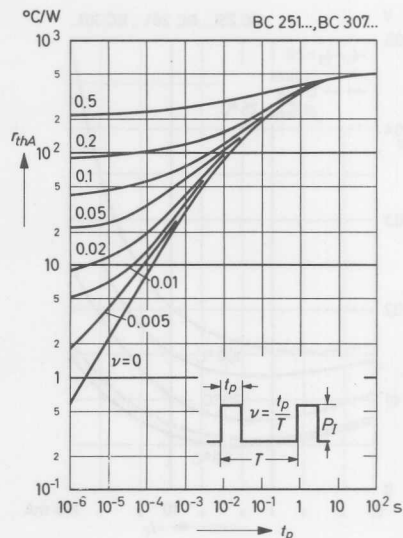
¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

BC 251..., BC 261..., BC 307...

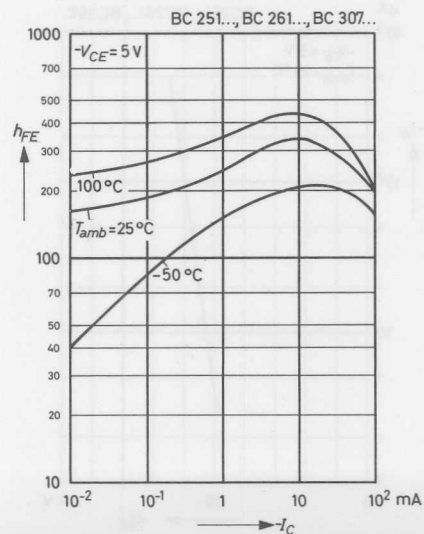
**Pulse thermal resistance
versus pulse duration**



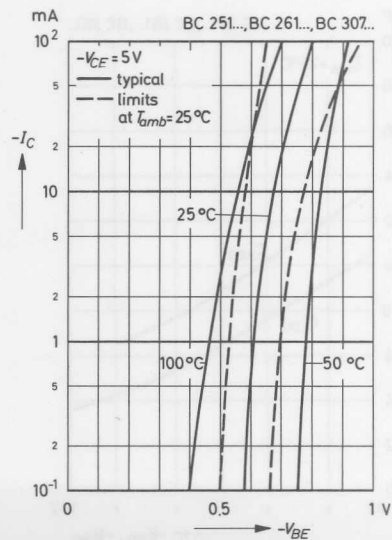
**Pulse thermal resistance
versus pulse duration**
(see note on page 244)



**DC current gain
versus collector current**

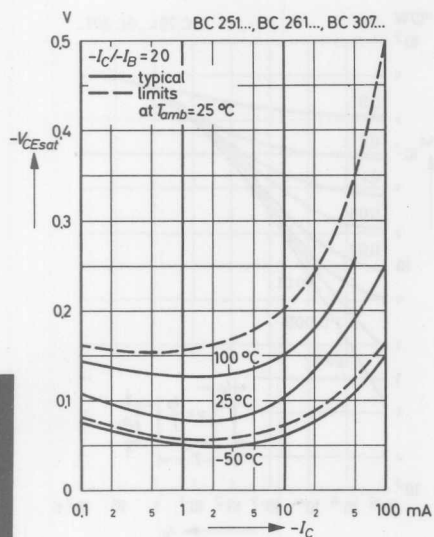


**Collector current versus
base emitter voltage**

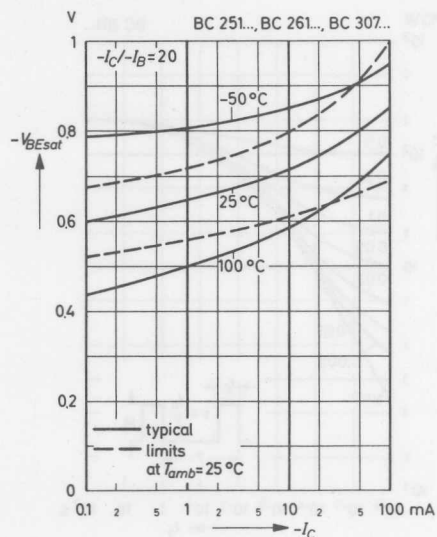


BC 251..., BC 261..., BC 307 ...

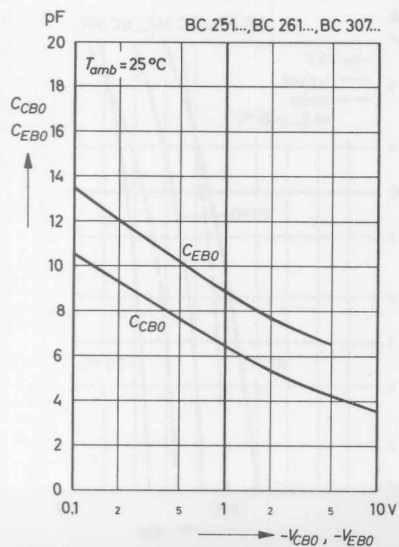
**Collector saturation voltage
versus collector current**



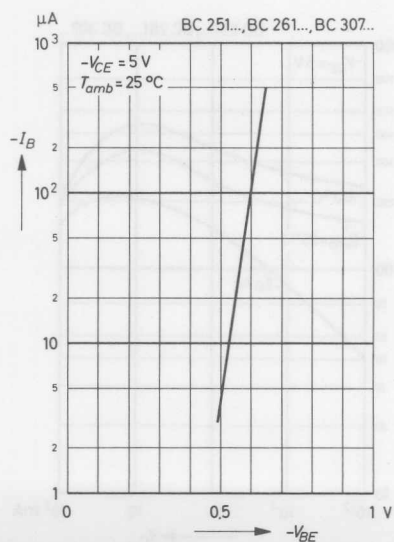
**Base saturation voltage
versus collector current**



**Collector base capacitance,
Emitter base capacitance
versus reverse bias voltage**

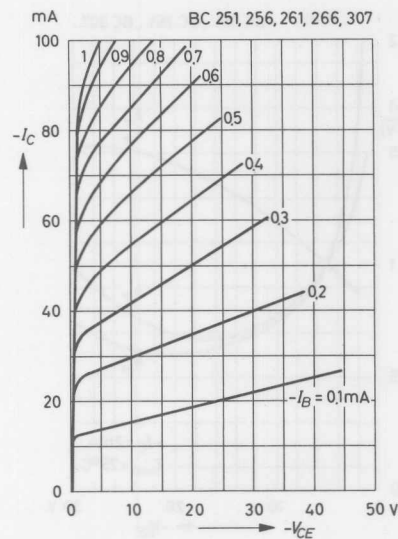


**Common emitter
input characteristic**

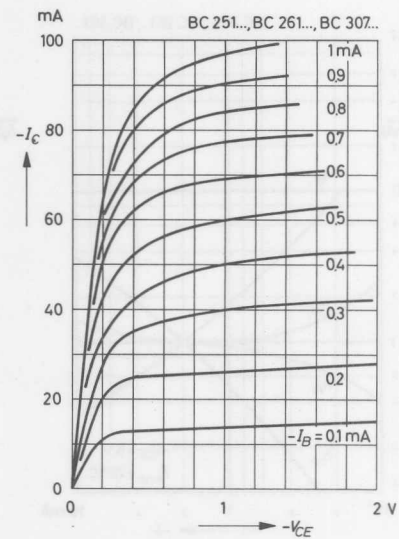


BC 251..., BC 261..., BC 307 ...

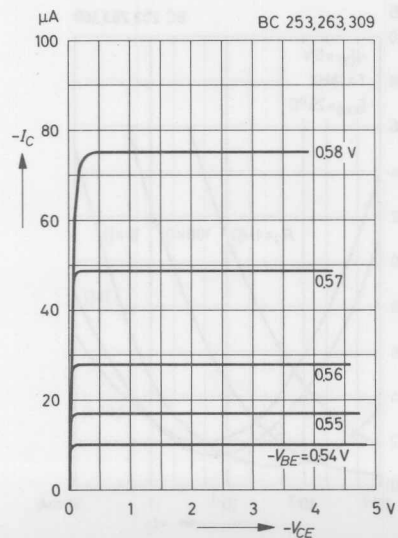
**Common emitter
collector characteristics**



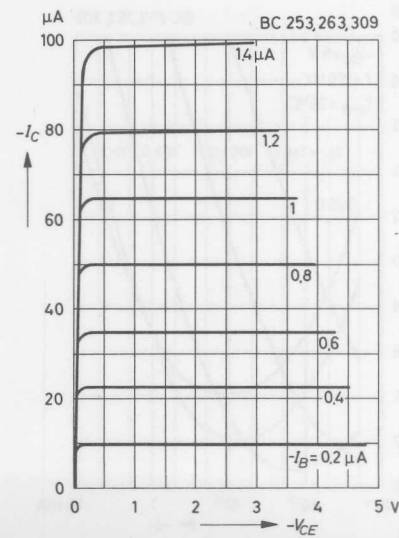
**Common emitter
collector characteristics**



**Common emitter
collector characteristics**

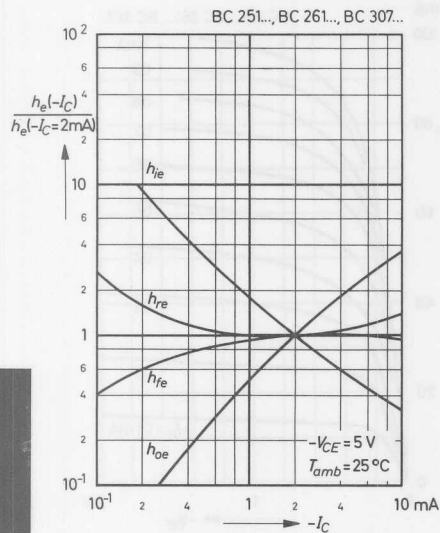


**Common emitter
collector characteristics**

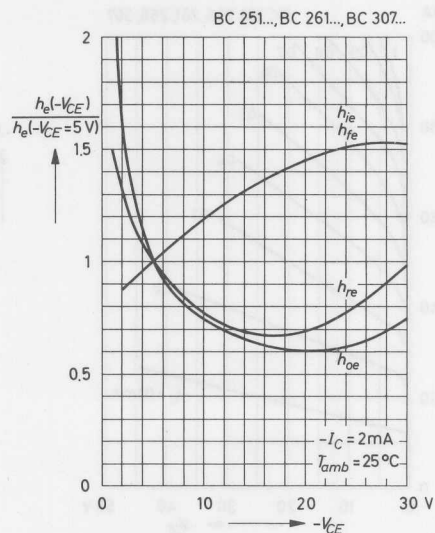


BC 251..., BC 261..., BC 307 ...

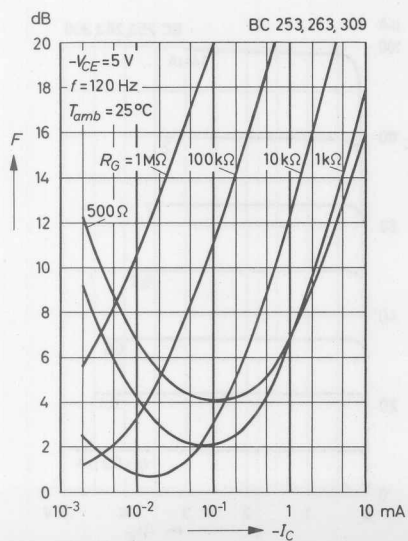
**Relative h -parameters
versus
collector current**



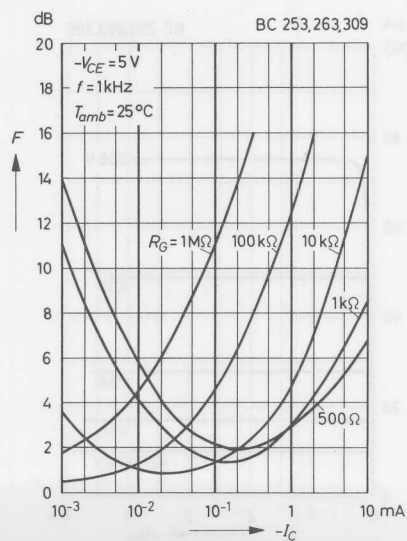
**Relative h -parameters
versus
collector emitter voltage**



**Noise figure
versus collector current**

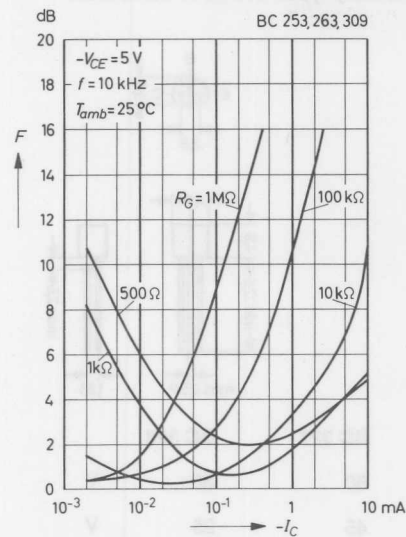


**Noise figure
versus collector current**

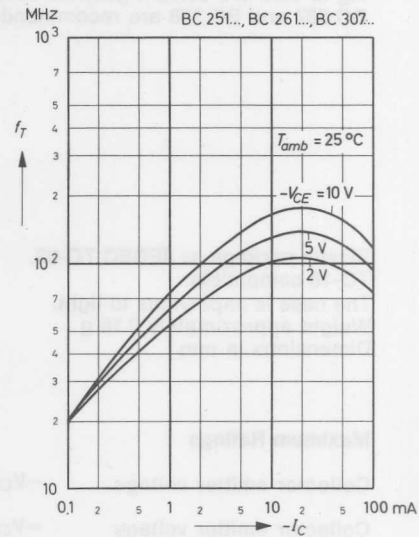


BC 251..., BC 261..., BC 307 ...

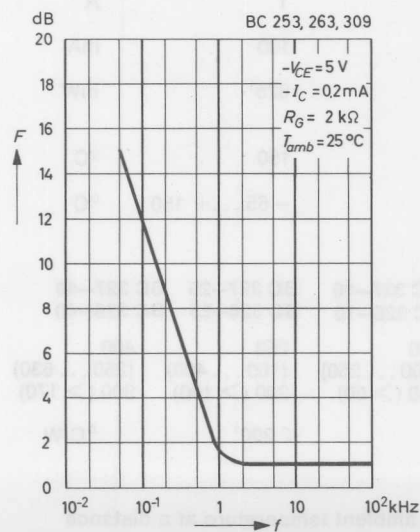
**Noise figure
versus collector current**



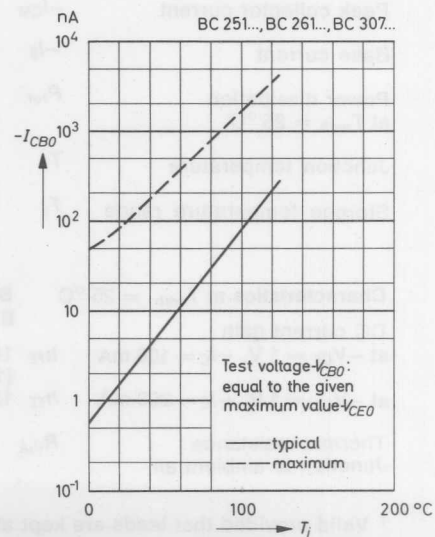
**Noise figure versus
collector emitter voltage**



**Noise figure
versus frequency**



**Collector cutoff current
versus ambient temperature**



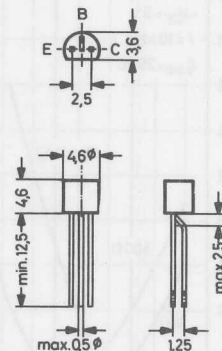
BC 327, BC 328

PNP Silicon Epitaxial Planar Transistors

for switching and amplifier applications. Especially suitable for AF-driver stages and low power output stages.

These types are subdivided into three groups -16, -25 and -40, according to their DC current gain. As complementary types the NPN transistors BC 337 and BC 338 are recommended.

Plastic package \approx JEDEC TO-92,
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm



Maximum Ratings

		BC 327	BC 328	
Collector emitter voltage	$-V_{CES}$	50	30	V
Collector emitter voltage	$-V_{CEO}$	45	25	V
Emitter base voltage	$-V_{EBO}$	5		V
Collector current	$-I_C$	800		mA
Peak collector current	$-I_{CM}$	1		A
Base current	$-I_B$	100		mA
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}	625 ¹		mW
Junction temperature	T_j	150		$^\circ\text{C}$
Storage temperature range	T_s	-55...+150		$^\circ\text{C}$

Characteristics at $T_{amb} = 25^\circ\text{C}$

	BC 327-16 BC 328-16	BC 327-25 BC 328-25	BC 327-40 BC 328-40
DC current gain			
at $-V_{CE} = 1\text{ V}$, $-I_C = 100\text{ mA}$	h_{FE} 160 (100...250)	250 (160...400)	400 (250...630)
at $-V_{CE} = 1\text{ V}$, $-I_C = 300\text{ mA}$	h_{FE} 130 (> 60)	200 (> 100)	300 (> 170)
Thermal resistance Junction to ambient air	R_{thA}	< 200 ¹	$^\circ\text{C/W}$

¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

BC 327, BC 328

Collector cutoff current

at $-V_{CE} = 25 \text{ V}$
 at $-V_{CE} = 45 \text{ V}$
 at $-V_{CE} = 25 \text{ V}, T_{amb} = 125^\circ\text{C}$
 at $-V_{CE} = 45 \text{ V}, T_{amb} = 125^\circ\text{C}$

BC 327	BC 328
$-I_{CES}$	$-$
$-I_{CES}$	$2 (< 100)$
$-I_{CES}$	< 10
$-I_{CES}$	< 10

Collector emitter breakdown voltage at $-I_C = 10 \text{ mA}$

$-V_{(BR)CEO}$	> 45	> 25	V
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Collector emitter breakdown voltage at $-I_C = 0.1 \text{ mA}$

$-V_{(BR)CES}$	> 50	> 30	V
----------------	--------	--------	------------

Emitter base breakdown voltage at $-I_E = 0.1 \text{ mA}$

$-V_{(BR)EBO}$	> 5	V
----------------	-------	------------

Collector saturation voltage at $-I_C = 500 \text{ mA}, -I_B = 50 \text{ mA}$

$-V_{CE \text{ sat}}$	< 0.7	V
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Base emitter voltage at $-V_{CE} = 1 \text{ V}, -I_C = 300 \text{ mA}$

$-V_{BE}$	< 1.2	V
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Gain bandwidth product at $-V_{CE} = 5 \text{ V}, -I_C = 10 \text{ mA}$ $f = 50 \text{ MHz}$

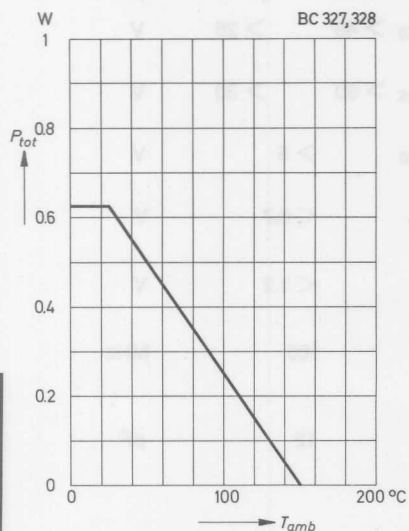
f_T	100	MHz
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Collector base capacitance at $-V_{CB} = 10 \text{ V}, f = 1 \text{ MHz}$

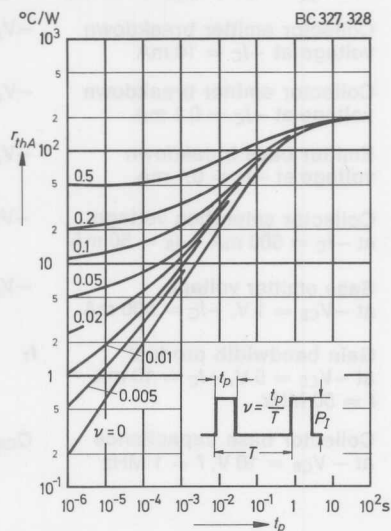
C_{CB0}	12	pF
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BC 327, BC 328

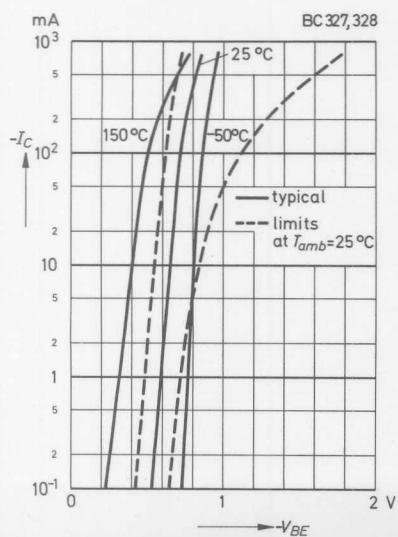
**Admissible power dissipation
versus ambient temperature**
(see note on page 250)



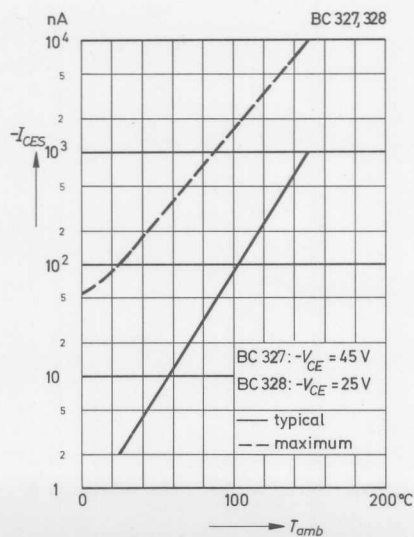
**Pulse thermal resistance
versus pulse duration**
(see note on page 250)



**Collector current
versus base emitter voltage**

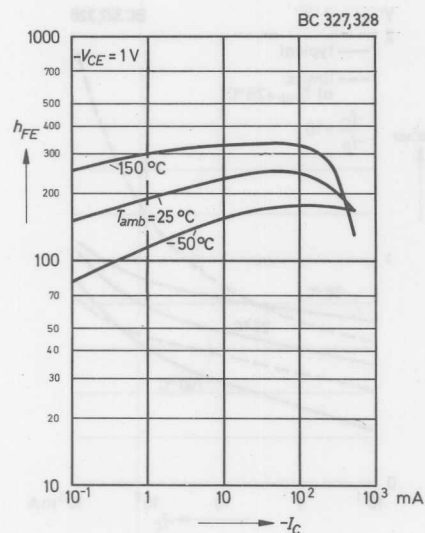


**Collector cutoff current
versus ambient temperature**

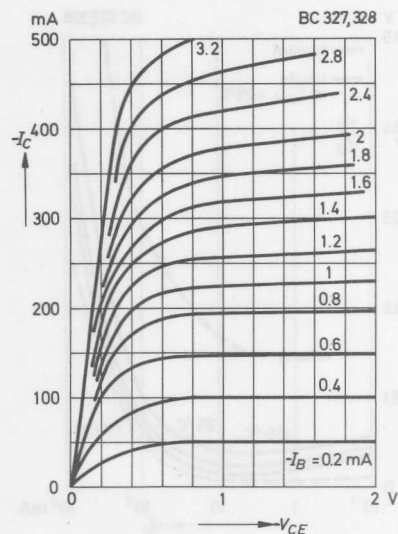


BC 327, BC 328

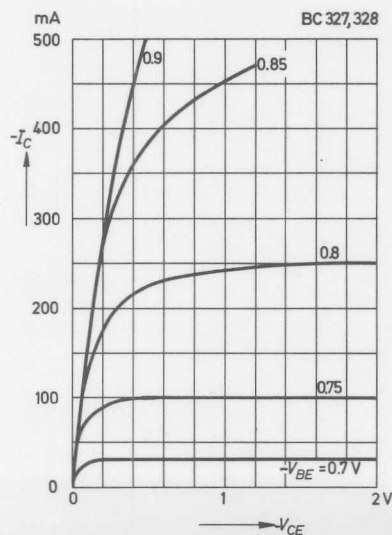
**DC current gain
versus collector current**



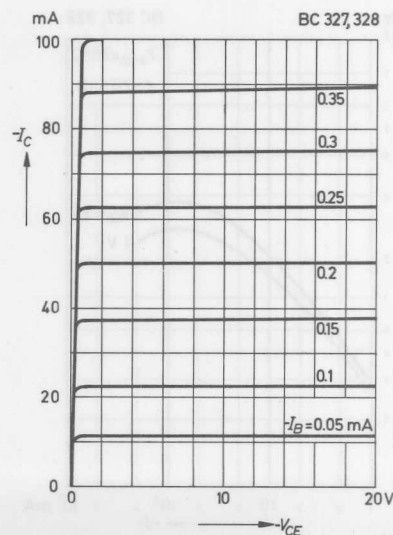
**Common emitter
collector characteristics**



**Common emitter
collector characteristics**

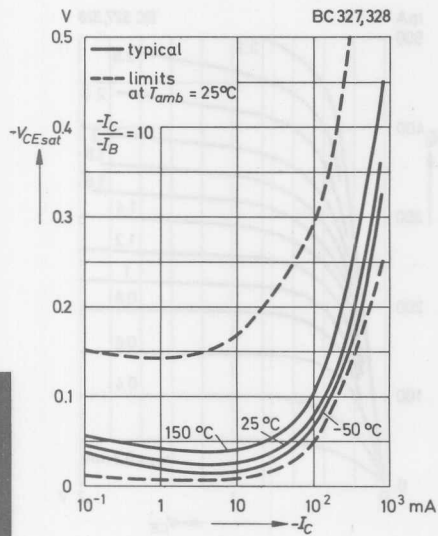


**Common emitter
collector characteristics**

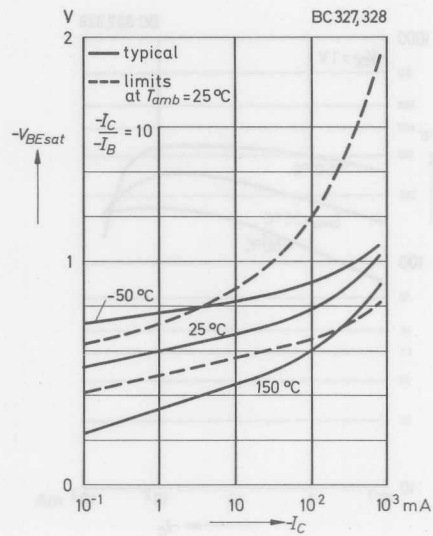


BC 327, BC 328

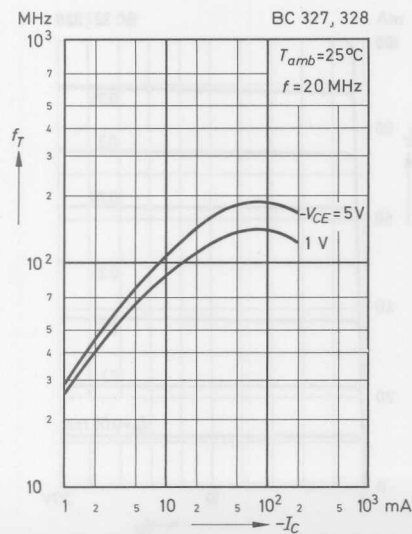
Collector saturation voltage
versus collector current



Base saturation voltage
versus collector current



Gain bandwidth product
versus collector current



BC 327, BC 328

PNP Silicon Epitaxial Planar Transistors
for switching and amplifier applications

The type BC 328 is subdivided into three groups: -5, -10 and -15, the type BC 327 into two groups: -5 and -10, according to the DC current gain. As complementary types the NPN transistors BC 327 and BC 328 are recommended.



Maximum ratings
Metal case JEDEC TO-18
50 °C according to DIN 41 575
Collector connected to case
Weight approximately 1 g
Dimensions in mm

Maximum ratings	BC 327	BC 328
Collector base voltage	$-V_{CB}$ 40 V	$-V_{CB}$ 40 V
Collector emitter voltage	$-V_{CE}$ 40 V	$-V_{CE}$ 40 V
Emitter base voltage	$-V_{EB}$ 5 V	$-V_{EB}$ 5 V
Collector current	$-I_C$ 500 mA	$-I_C$ 500 mA
Base current	$-I_B$ 50 mA	$-I_B$ 50 mA
Power dissipation	P_{tot} 0.5 W	P_{tot} 0.5 W
at $T_{amb} = 25^\circ\text{C}$		
at $T_C = 25^\circ\text{C}$		
Junction temperature	T_J 100 °C	T_J 100 °C
Storage temperature range	T_S -55...+200 °C	T_S -55...+200 °C

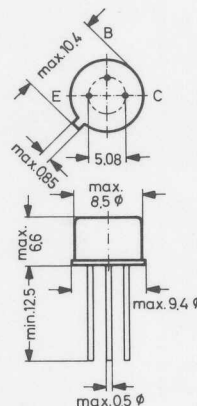
Characteristics at $T_J = 25^\circ\text{C}$	BC 327-5, BC 328-5	BC 327-10, BC 328-10	BC 327-15, BC 328-15
DC current gain			
at $-V_{CE} = 5\text{ V}, -I_C = 0.1\text{ mA}$	β_{DC} 40	β_{DC} 40	β_{DC} 40
at $-V_{CE} = 5\text{ V}, -I_C = 10\text{ mA}$	β_{DC} 40	β_{DC} 40	β_{DC} 40
at $-V_{CE} = 5\text{ V}, -I_C = 100\text{ mA}$	β_{DC} 30	β_{DC} 30	β_{DC} 30
Collector saturation voltage			
at $-I_C = 150\text{ mA}, -I_B = 15\text{ mA}$	$-V_{CE(sat)}$ < 0.4 V	$-V_{CE(sat)}$ < 0.4 V	$-V_{CE(sat)}$ < 0.4 V
Base saturation voltage			
at $-I_C = 150\text{ mA}, -I_B = 15\text{ mA}$	$-V_{BE(sat)}$ 0.85 (< 1.2) V	$-V_{BE(sat)}$ 0.85 (< 1.2) V	$-V_{BE(sat)}$ 0.85 (< 1.2) V

BC 360, BC 361

PNP Silicon Epitaxial Planar Transistors for switching and amplifier applications

The type BC 360 is subdivided into three groups, -6, -10 and -16, the type BC 361 into two groups, -6 and -10, according to the DC current gain. As complementary types the NPN transistors BC 340 and BC 341 are recommended.

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

	BC 360	BC 361
Collector base voltage	$-V_{CB0}$ 40	60 V
Collector emitter voltage	$-V_{CE0}$ 40	60 V
Emitter base voltage	$-V_{EB0}$ 5	5 V
Collector current	$-I_C$ 500	mA
Base current	$-I_B$ 50	mA
Power dissipation		
at $T_{amb} = 25^\circ\text{C}$	P_{tot} 0.8	W
at $T_C = 25^\circ\text{C}$	P_{tot} 3	W
Junction temperature	T_j 200	$^\circ\text{C}$
Storage temperature range	T_s -55 ... +200	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

	BC 360-6 BC 361-6	BC 360-10 BC 361-10	BC 360-16
DC current gain			
at $-V_{CE} = 5\text{ V}$, $-I_C = 0.1\text{ mA}$	h_{FE} 40	65	100
at $-V_{CE} = 5\text{ V}$, $-I_C = 50\text{ mA}$	h_{FE} 63	100	160
	(40...100)	(63...160)	(100...250)
at $-V_{CE} = 5\text{ V}$, $-I_C = 500\text{ mA}$	h_{FE} 20	30	48
Collector saturation voltage	$-V_{CE sat}$ < 0.4		V
at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$			
Base saturation voltage	$-V_{BE sat}$ 0.95 (< 1.2)		V
at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$			

BC 360, BC 361

Collector cutoff current

at $-V_{CE} = 40 \text{ V}$
 at $-V_{CE} = 60 \text{ V}$
 at $-V_{CE} = 40 \text{ V}, T_i = 150^\circ\text{C}$
 at $-V_{CE} = 60 \text{ V}, T_i = 150^\circ\text{C}$

	BC 360	BC 361
$-I_{CES}$	10 (< 100)	— nA
$-I_{CES}$	—	10 (< 100) nA
$-I_{CES}$	10 (< 100)	— μA
$-I_{CES}$	—	10 (< 100) μA

Collector emitter breakdown voltage

at $-I_C = 0.1 \text{ mA}$
 at $-I_C = 30 \text{ mA}$
 (pulsed 200 μs , 1%)

$-V_{(BR)CES}$	> 40	> 60 V
$-V_{(BR)CEO}$	> 40	> 60 V

Gain bandwidth product

at $-V_{CE} = 10 \text{ V}, -I_C = 50 \text{ mA}$,
 $f = 50 \text{ MHz}$

f_T	250	MHz
-------	-----	-----

Collector base capacitance

at $-V_{CBO} = 10 \text{ V}, f = 1 \text{ MHz}$

C_{CBO}	6.5	pF
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Emitter base capacitance

at $-V_{EBO} = 0.5 \text{ V}, f = 1 \text{ MHz}$

C_{EBO}	25	pF
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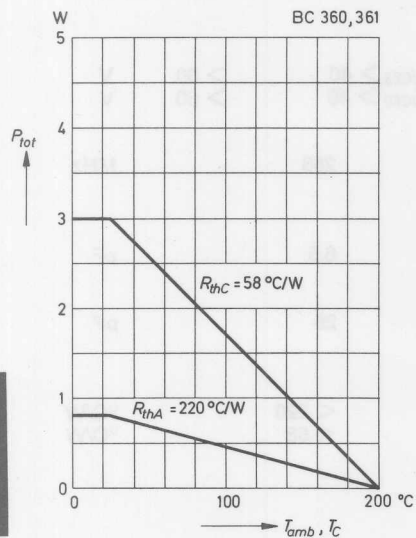
Thermal resistance

Junction to ambient air
 Junction to case

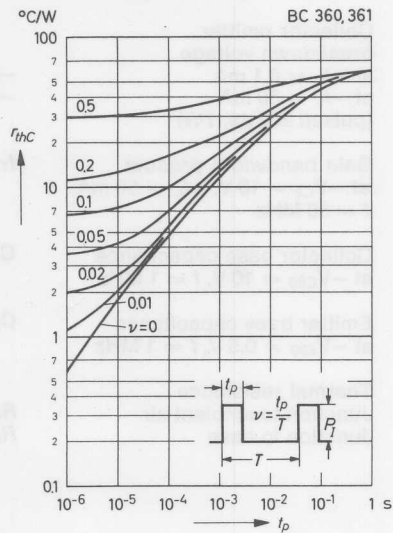
R_{thA}	< 220	$^\circ\text{C/W}$
R_{thC}	< 58	$^\circ\text{C/W}$

BC 360, BC 361

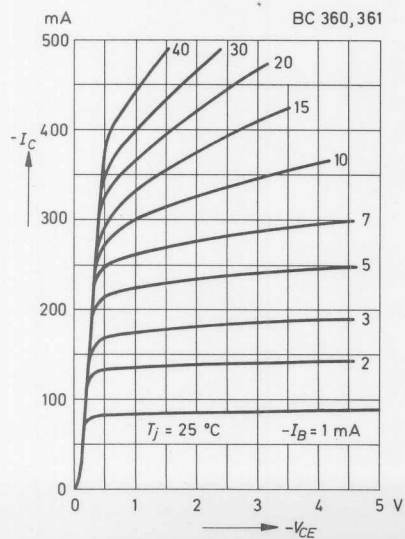
**Admissible power dissipation
versus temperature**



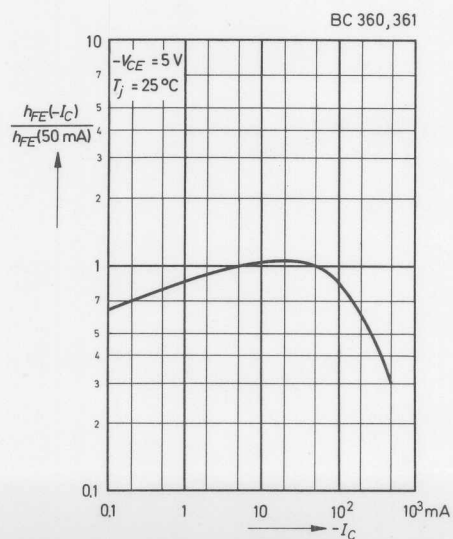
**Pulse thermal resistance
versus pulse duration**



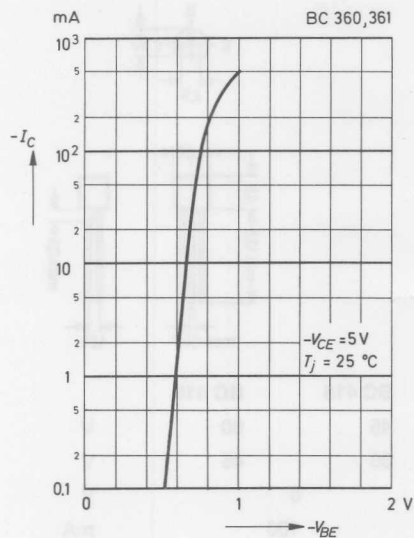
**Common emitter
collector characteristics**



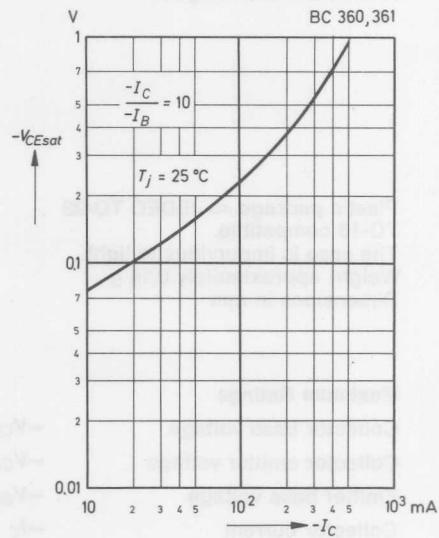
**Relative DC current gain
versus collector current**



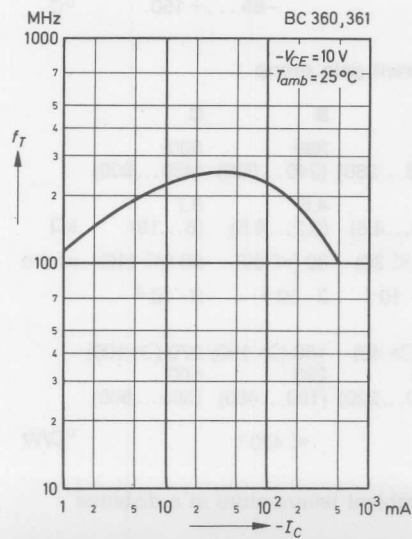
**Collector current
versus base emitter voltage**



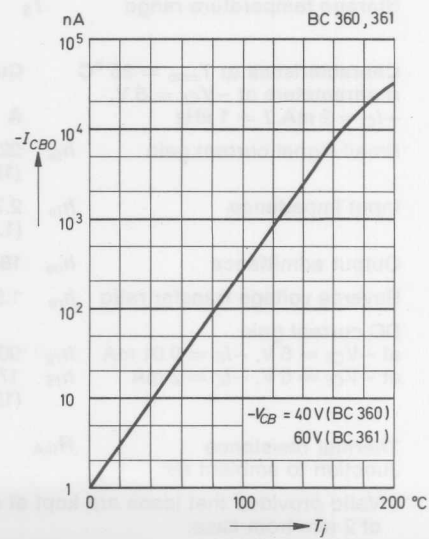
**Collector saturation voltage
versus collector current**



**Gain bandwidth product
versus collector current**



**Collector cutoff current
versus junction temperature**



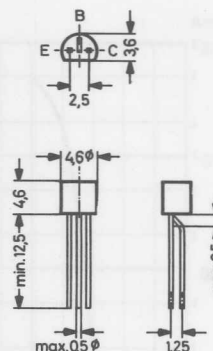
BC 415, BC 416

PNP Silicon Epitaxial Planar Transistors

for use in high-quality, low-noise AF and DC amplifiers. Complementary types are the NPN transistors BC 413 and BC 414.

These types are subdivided into three groups -6, -10 and -16, according to their DC current gain.

Plastic package \approx JEDEC TO-92
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm



Maximum Ratings		BC 415	BC 416	
Collector base voltage	$-V_{CB0}$	45	50	V
Collector emitter voltage	$-V_{CE0}$	30	45	V
Emitter base voltage	$-V_{EB0}$		5	V
Collector current	$-I_C$		100	mA
Base current	$-I_B$		20	mA
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}		300 ¹	mW
Junction temperature	T_j		150	$^\circ\text{C}$
Storage temperature range	T_S		$-65 \dots +150$	$^\circ\text{C}$

Characteristics at $T_{amb} = 25^\circ\text{C}$
 h -parameters at $-V_{CE} = 5\text{ V}$,
 $-I_C = 2\text{ mA}$, $f = 1\text{ kHz}$

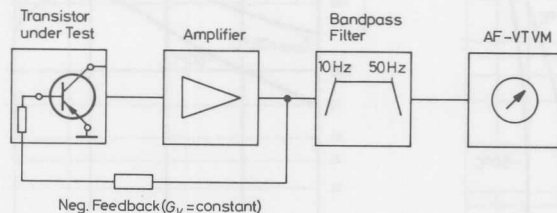
Current gain group

		A	B	C	
Small signal current gain	h_{fe}	222 (125...260)	330 (240...500)	600 (450...900)	
Input impedance	h_{ie}	2.7 (1.6...4.5)	4.5 (3.2...8.5)	8.7 (6...15)	k Ω
Output admittance	h_{oe}	18 (< 30)	30 (< 60)	60 (< 110)	μmho
Reverse voltage transfer ratio	h_{re}	$1.5 \cdot 10^{-4}$	$2 \cdot 10^{-4}$	$3 \cdot 10^{-4}$	
DC current gain					
at $-V_{CE} = 5\text{ V}$, $-I_C = 0.01\text{ mA}$	h_{FE}	90 (> 40)	150 (> 100)	270 (> 100)	
at $-V_{CE} = 5\text{ V}$, $-I_C = 2\text{ mA}$	h_{FE}	170 (120...220)	290 (180...460)	500 (380...800)	
Thermal resistance Junction to ambient air	R_{thA}	< 420 ¹			$^\circ\text{C/W}$

¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

BC 415, BC 416

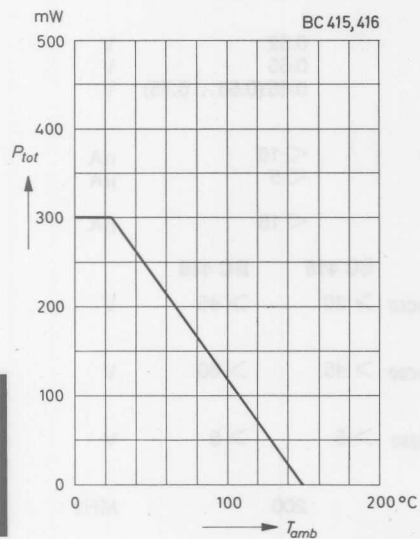
Collector saturation voltage at $-I_C = 10 \text{ mA}$, $-I_B = 0.5 \text{ mA}$	$-V_{CE \text{ sat}}$	0.075 (< 0.25)	V	
at $-I_C = 100 \text{ mA}$, $-I_B = 5 \text{ mA}$	$-V_{CE \text{ sat}}$	0.25 (< 0.6)	V	
Base saturation voltage at $-I_C = 100 \text{ mA}$, $-I_B = 5 \text{ mA}$	$-V_{BE \text{ sat}}$	0.9	V	
Base emitter voltage at $-V_{CE} = 5 \text{ V}$, $-I_C = 0.01 \text{ mA}$	$-V_{BE}$	0.52	V	
at $-V_{CE} = 5 \text{ V}$, $-I_C = 0.1 \text{ mA}$	$-V_{BE}$	0.55	V	
at $-V_{CE} = 5 \text{ V}$, $-I_C = 2 \text{ mA}$	$-V_{BE}$	0.65 (0.55...0.75)	V	
Collector cutoff current at $-V_{CB} = 30 \text{ V}$	$-I_{CB0}$	< 15	nA	
at $-V_{CB} = 30 \text{ V}$, $T_{amb} = 150^\circ\text{C}$	$-I_{CB0}$	< 5	μA	
Emitter cutoff current at $-V_{EB} = 4 \text{ V}$	$-I_{EB0}$	< 15	nA	
		BC 415	BC 416	
Collector emitter breakdown voltage at $-I_{CE} = 10 \text{ mA}$	$-V_{(BR)CE0}$	> 30	> 45	V
Collector base breakdown voltage at $-I_{CB} = 10 \mu\text{A}$	$-V_{(BR)CB0}$	> 45	> 50	V
Emitter base breakdown voltage at $-I_{EB} = 10 \mu\text{A}$	$-V_{(BR)EB0}$	> 5	> 5	V
Gain bandwidth product at $-V_{CE} = 5 \text{ V}$, $-I_C = 10 \text{ mA}$, $f = 100 \text{ MHz}$	f_T	200		MHz
Collector base capacitance at $-V_{CB0} = 10 \text{ V}$, $f = 1 \text{ MHz}$	C_{CB0}	4.5		pF
Noise figure at $-V_{CE} = 5 \text{ V}$, $-I_C = 0.2 \text{ mA}$, $R_G = 2 \text{ k}\Omega$, $f = 30 \text{ Hz} \dots 15 \text{ kHz}$	F	< 2		dB
Equivalent noise EMF (referred to base) at $-V_{CE} = 5 \text{ V}$, $-I_C = 0.2 \text{ mA}$, $R_G = 2 \text{ k}\Omega$, $f = 10 \dots 50 \text{ Hz}$	v_r	< 0.11		μV



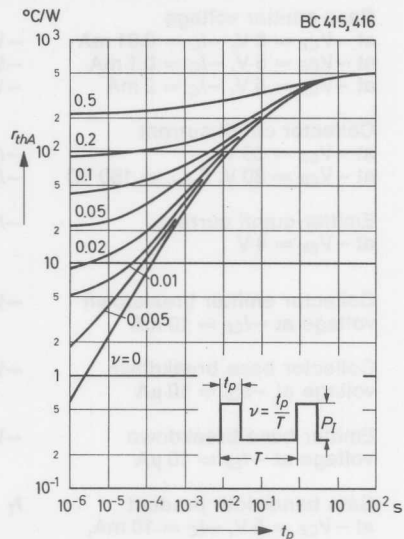
Test circuit for equivalent noise EMF

BC 415, BC 416

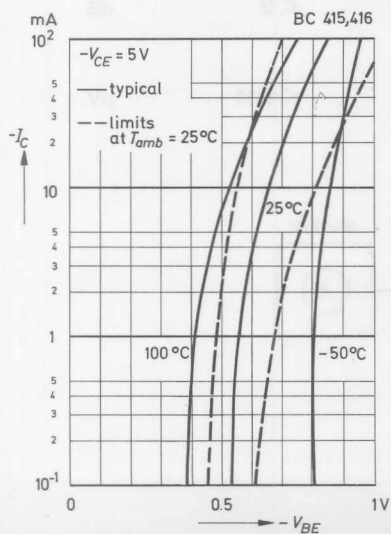
**Admissible power dissipation
versus ambient temperature**
(see note on page 260)



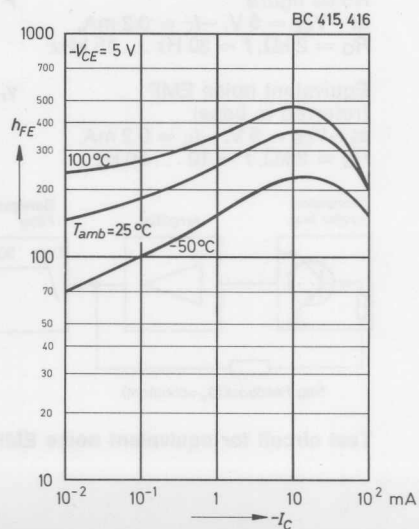
**Pulse thermal resistance
versus pulse duration**
(see note on page 260)



**Collector current
versus base emitter voltage**

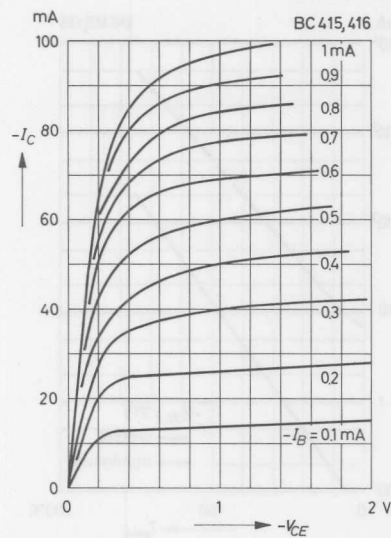


**DC current gain
versus collector current**

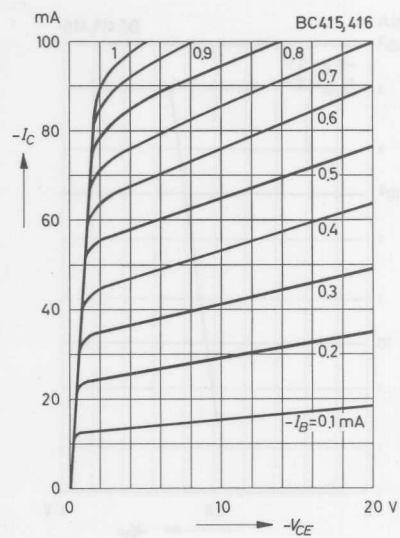


BC 415, BC 416

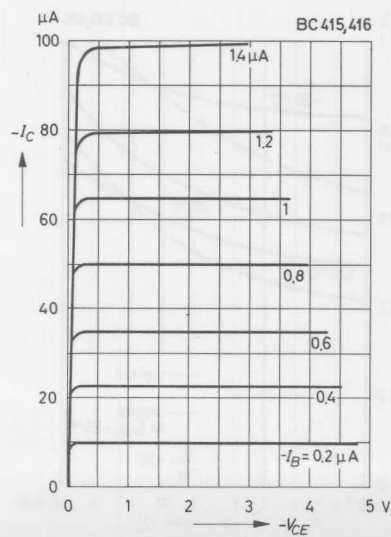
Common emitter
collector characteristics



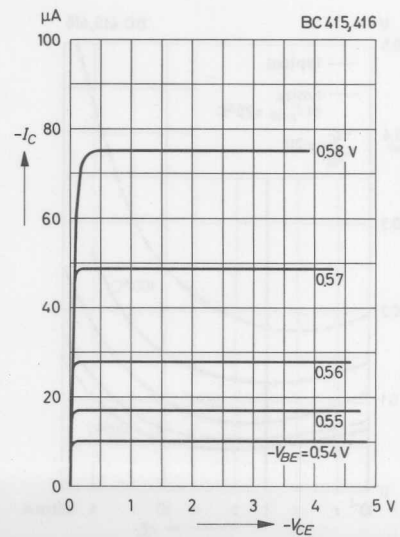
Common emitter
collector characteristics



Common emitter
collector characteristics

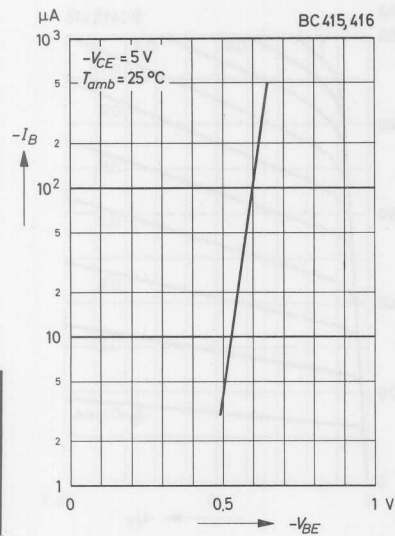


Common emitter
collector characteristics

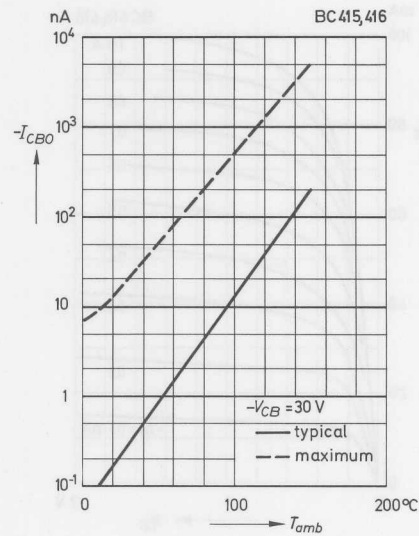


BC 415, BC 416

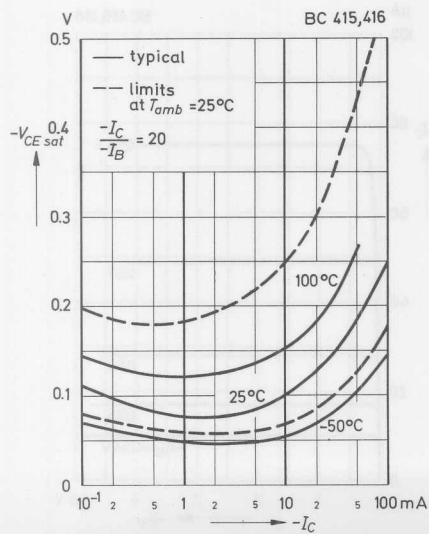
**Common emitter
input characteristic**



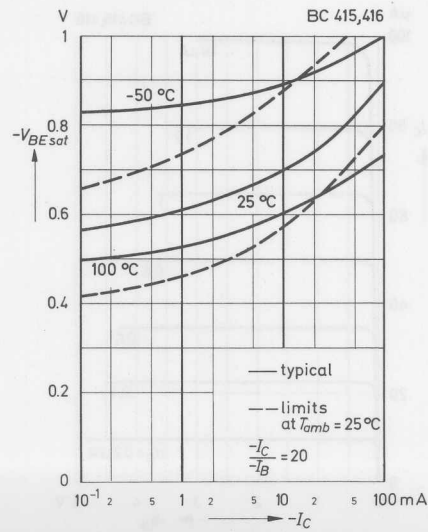
**Collector cutoff current
versus ambient temperature**



**Collector saturation voltage
versus collector current**

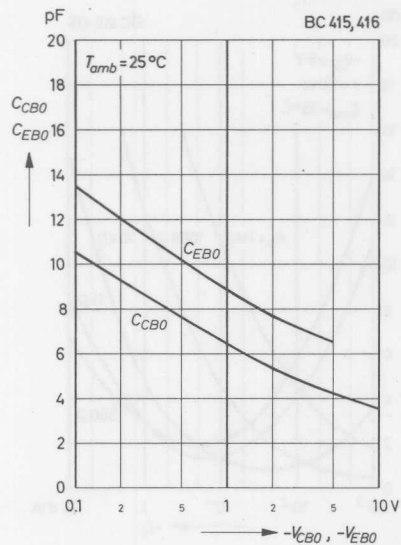


**Base saturation voltage
versus collector current**

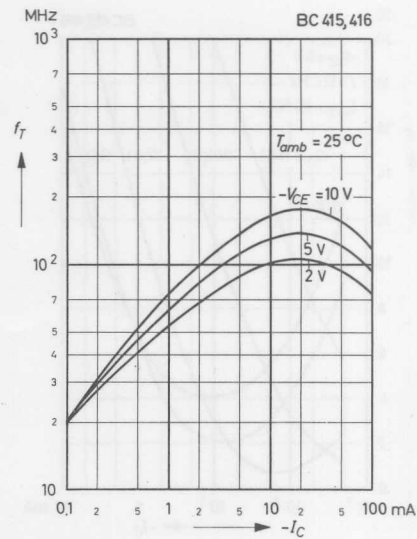


BC 415, BC 416

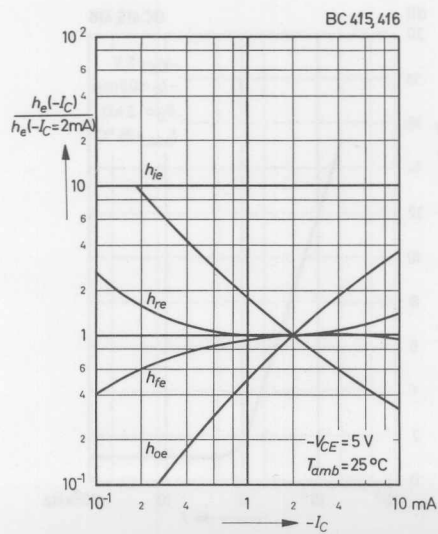
Collector base capacitance,
Emitter base capacitance
versus reverse bias voltage



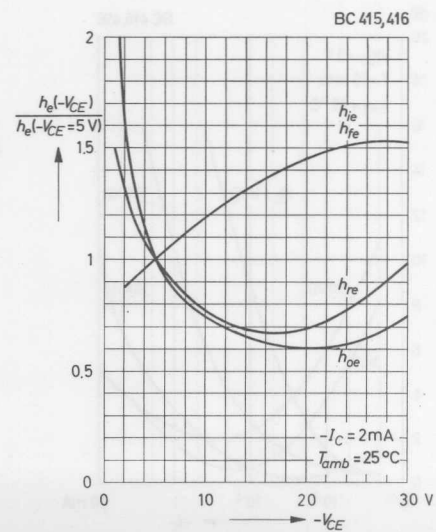
Gain bandwidth product
versus
collector current



Relative h -parameters
versus
collector current

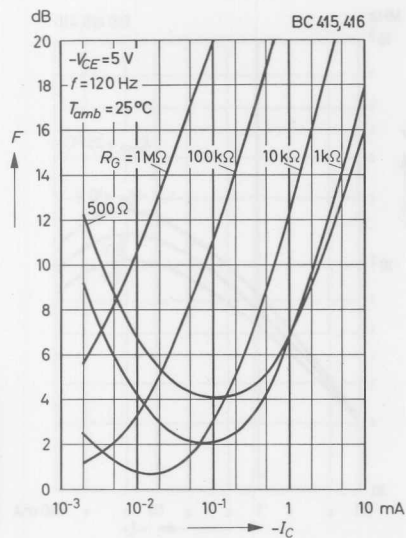


Relative h -parameters
versus
collector emitter voltage

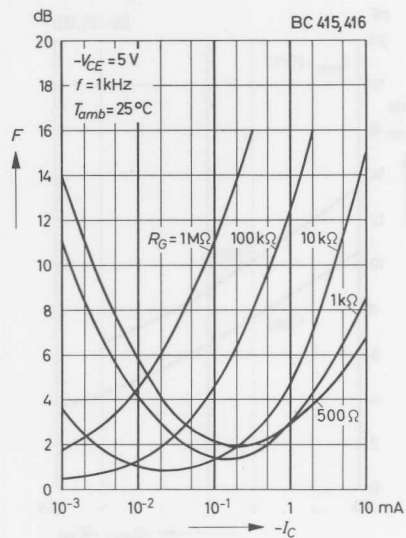


BC 415, BC 416

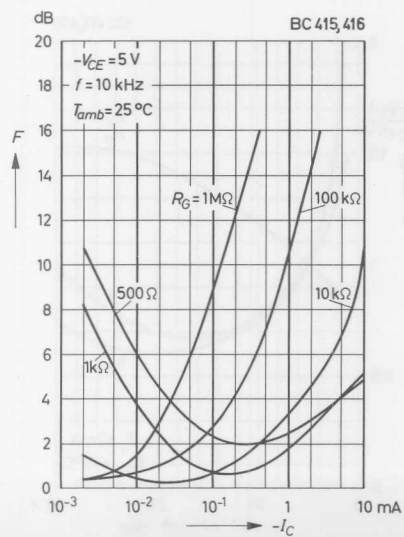
Noise figure
versus collector current



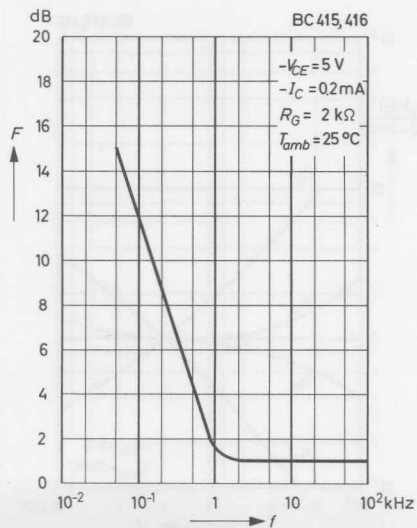
Noise figure
versus collector current



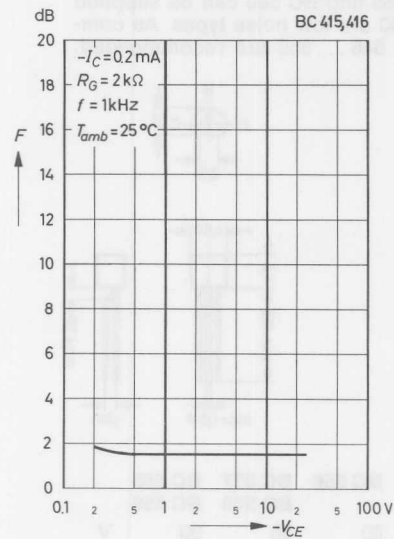
Noise figure
versus collector current



Noise figure
versus frequency



Noise figure
versus collector emitter voltage



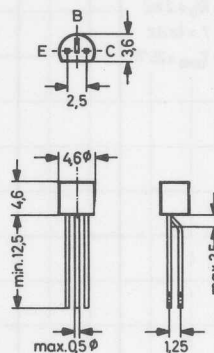
BC 556 ... BC 560

PNP Silicon Epitaxial Planar Transistors

for switching and AF amplifier applications.

These transistors are subdivided into three groups A, B and C according to their current gain. The types BC 556 and BC 557 are available in groups A and B, however, the types BC 558, BC 559 and BC 560 can be supplied in all three groups. The BC 559 and BC 560 are low noise types. As complementary types the NPN transistors BC 546 ... 550 are recommended.

Plastic package \approx JEDEC TO-92
TO-18 compatible
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm



Maximum Ratings

		BC 556	BC 557 BC 560	BC 558 BC 559	
Collector base voltage	$-V_{CB0}$	80	50	30	V
Collector emitter voltage	$-V_{CES}$	80	50	30	V
Collector emitter voltage	$-V_{CEO}$	65	45	30	V
Emitter base voltage	$-V_{EB0}$	5	5	5	V
Collector current	$-I_C$	100	100	100	mA
Peak collector current	$-I_{CM}$	200	200	200	mA
Peak base current	$-I_{BM}$	200	200	200	mA
Peak emitter current	$-I_{EM}$	200	200	200	mA
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{Tot}		500 ¹⁾		mW
Junction temperature	T_j		150		$^\circ\text{C}$
Storage temperature range	T_S		- 65 ... +150		$^\circ\text{C}$

¹⁾ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

Characteristics at $T_{amb} = 25^\circ\text{C}$ **h -Parameters at $-V_{CE} = 5\text{ V}$,
 $-I_C = 2\text{ mA}$, $f = 1\text{ kHz}$** **Current Gain Group****A B C**

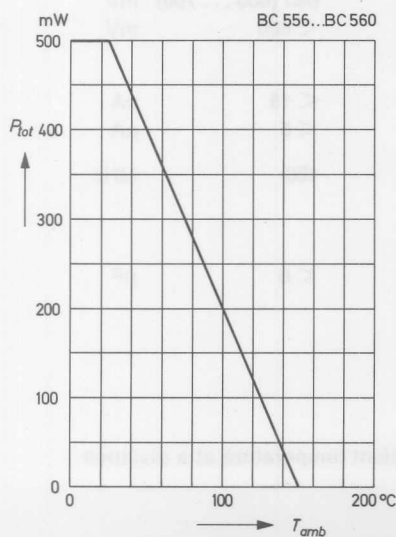
Current gain	h_{fe}	220 (125...260)	330 (240...500)	600 (450...900)
Input impedance	h_{ie}	2.7 (1.6...4.5)	4.5 (3.2...8.5)	8.7 (6...15) kΩ
Output admittance	h_{oe}	18 (< 30)	30 (< 60)	60 (< 110) μmho
Reverse voltage transfer ratio	h_{re}	$1.5 \cdot 10^{-4}$	$2 \cdot 10^{-4}$	$3 \cdot 10^{-4}$
DC current gain				
at $-V_{CE} = 5 \text{ V}$, $I_C = 10 \text{ μA}$	h_{FE}	90	150	270
at $-V_{CE} = 5 \text{ V}$, $I_C = 2 \text{ mA}$	h_{FE}	180	290	500
at $-V_{CE} = 5 \text{ V}$, $I_C = 100 \text{ mA}$	h_{FE}	120	200	400
Thermal resistance Junction to ambient air	R_{thA}	< 250 ¹⁾		°C/W
Collector saturation voltage				
at $-I_C = 10 \text{ mA}$, $-I_B = 0.5 \text{ mA}$	$-V_{CE\text{ sat}}$	90 (< 300)		mV
at $-I_C = 100 \text{ mA}$, $-I_B = 5 \text{ mA}$	$-V_{CE\text{ sat}}$	250 (< 650)		mV
Base saturation voltage				
at $-I_C = 10 \text{ mA}$, $-I_B = 0.5 \text{ mA}$	$-V_{BE\text{ sat}}$	700		mV
at $-I_C = 100 \text{ mA}$, $-I_B = 5 \text{ mA}$	$-V_{BE\text{ sat}}$	900		mV
Base emitter voltage				
at $-V_{CE} = 5 \text{ V}$, $-I_C = 2 \text{ mA}$	$-V_{BE}$	660 (600 ... 750)		mV
at $-V_{CE} = 5 \text{ V}$, $-I_C = 10 \text{ mA}$	$-V_{BE}$	< 800		mV
Collector cutoff current				
at $-V_{CB} = 30 \text{ V}$	$-I_{CB0}$	< 15		nA
at $-V_{CB} = 30 \text{ V}$, $T_j = 150 \text{ °C}$	$-I_{CB0}$	< 5		μA
Gain bandwidth product				
at $-V_{CE} = 5 \text{ V}$, $-I_C = 10 \text{ mA}$, $f = 100 \text{ MHz}$	f_T	150		MHz
Collector base capacitance				
at $-V_{CB} = 10 \text{ V}$, $f = 1 \text{ MHz}$	C_{CB0}	< 6		pF

¹⁾ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

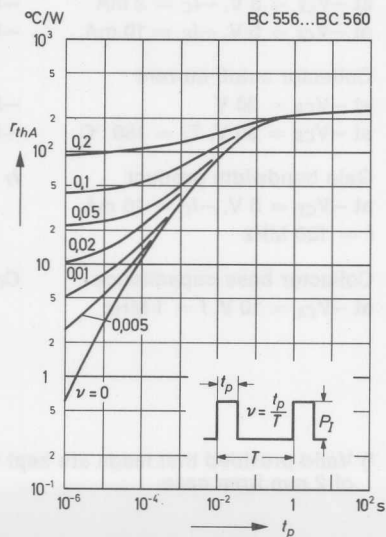
BC 556 ... BC 560

		BC 556	BC 559	
		BC 557	BC 560	
		BC 558		
Noise figure				
at $-V_{CE} = 5 \text{ V}$, $-I_C = 200 \mu\text{A}$,	F	2 (< 10)	1 (< 4)	dB
$R_G = 2 \text{ k}\Omega$, $f = 1 \text{ kHz}$, $\Delta f = 200 \text{ Hz}$				
Noise figure		BC 559	BC 560	
at $-V_{CE} = 5 \text{ V}$, $-I_C = 200 \mu\text{A}$,	F	1.2 (< 4)	1.2 (< 2)	dB
$R_G = 2 \text{ k}\Omega$, $f = 30 \dots 15\,000 \text{ Hz}$				
Equivalent noise EMF	v_r	< 0.11	< 0.11	μV
at $-V_{CE} = 5 \text{ V}$, $-I_C = 200 \mu\text{A}$,				
$R_G = 2 \text{ k}\Omega$, $f = 10 \dots 50 \text{ Hz}$				

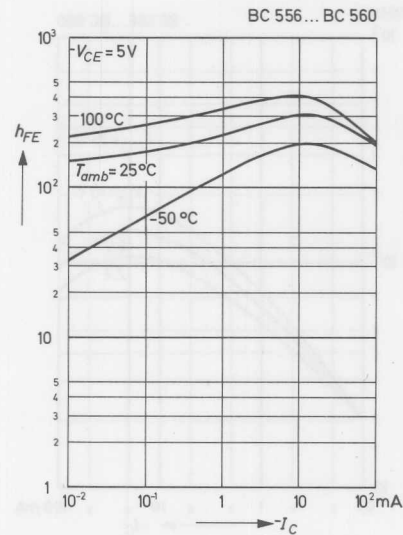
**Admissible power dissipation
versus temperature**
(see note on page 269)



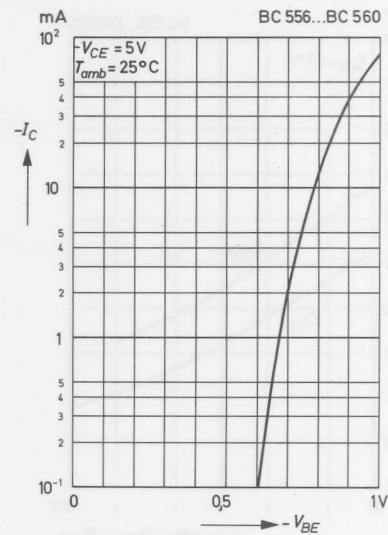
**Pulse thermal resistance
versus pulse duration**
(see note on page 269)



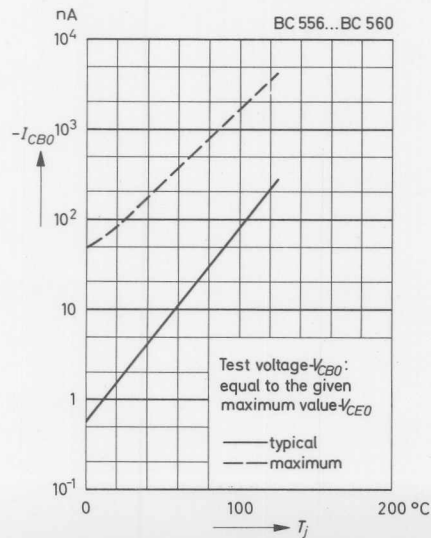
**DC current gain
versus collector current**



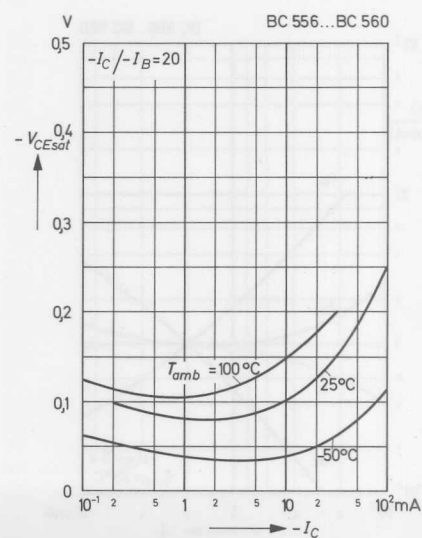
**Collector current versus
base emitter voltage**



**Collector cutoff current
versus junction temperature**

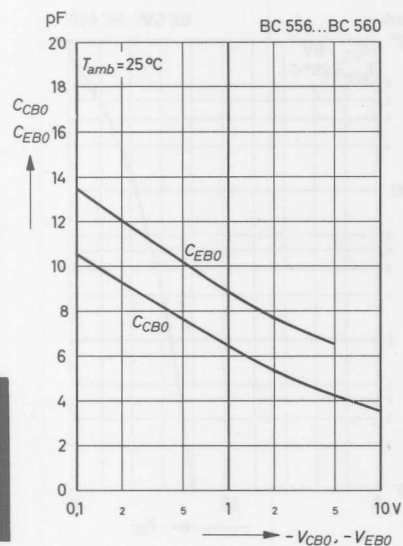


**Collector saturation voltage
versus collector current**

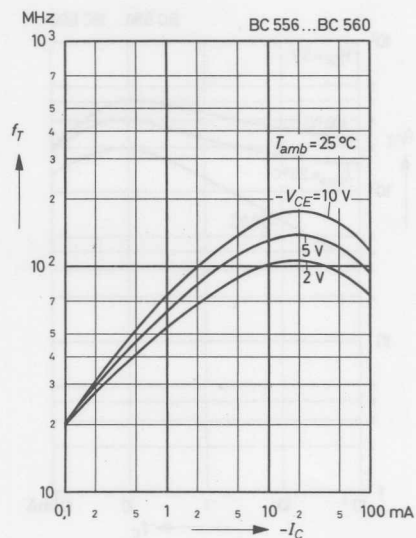


BC 556 ... BC 560

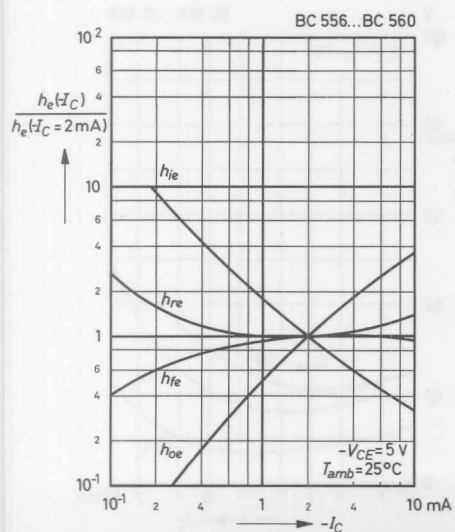
Collector base capacitance,
Emitter base capacitance
versus reverse bias voltage



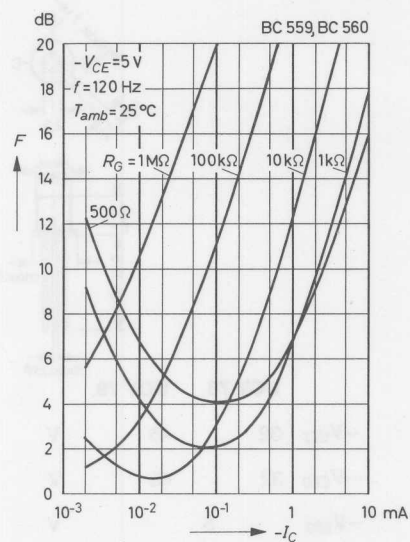
Gain bandwidth product
versus collector current



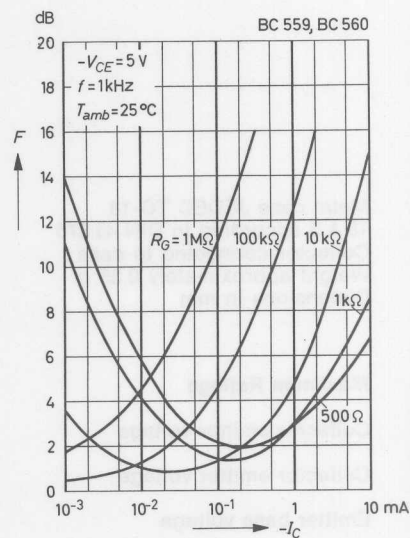
Relative h -parameters
versus
collector current



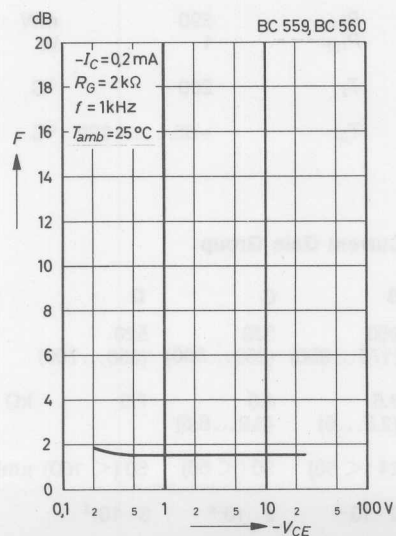
**Noise figure
versus collector current**



**Noise figure
versus collector current**



**Noise figure versus
collector emitter voltage**



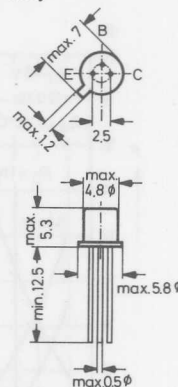
BCY 78, BCY 79

PNP Silicon Epitaxial Planar Transistors

for switching and amplifier applications in commercial electronic design

These Transistors are subdivided into four groups A, B, C and D according to their current gain. Type BCY 79 is available in groups A, B and C only.

Metal case JEDEC TO-18
18 A 3 according to DIN 41876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm



Maximum Ratings

	BCY 78	BCY 79
Collector emitter voltage	$-V_{CES}$ 32	45 V
Collector emitter voltage	$-V_{CEO}$ 32	45 V
Emitter base voltage	$-V_{EB0}$ 5	V
Collector current	$-I_C$ 200	mA
Base current	$-I_B$ 50	mA
Power dissipation		
at $T_{amb} = 25^\circ\text{C}$	P_{tot} 390	mW
at $T_C = 45^\circ\text{C}$	P_{tot} 1	W
Junction temperature	T_j 200	$^\circ\text{C}$
Storage temperature range	T_S -65...+200	$^\circ\text{C}$

Characteristics at $T_{amb} = 25^\circ\text{C}$

h -parameters at $-V_{CE} = 5\text{ V}$,
 $-I_C = 2\text{ mA}$, $f = 1\text{ kHz}$

		Current Gain Group			
		A	B	C	D
Small signal current gain	h_{fe}	200 (125...250)	260 (175...350)	330 (250...500)	520 (350...700)
Input impedance	h_{ie}	2.7 (1.6...4.5)	3.6 (2.5...6)	4.5 (3.2...8.5)	7.5 k Ω
Output admittance	h_{oe}	18 (< 30)	24 (< 50)	30 (< 60)	50 (< 100) μmho
Reverse voltage transfer ratio	h_{re}	$1.5 \cdot 10^{-4}$	$2 \cdot 10^{-4}$	$2 \cdot 10^{-4}$	$3 \cdot 10^{-4}$

BCY 78, BCY 79

		Current Gain Group			
		A	B	C	D
DC current gain					
at $-V_{CE} = 5\text{ V}$, $-I_C = 10\text{ }\mu\text{A}$	h_{FE}	140	200 (> 30)	270 (> 40)	340 (> 100)
at $-V_{CE} = 5\text{ V}$, $-I_C = 2\text{ mA}$	h_{FE}	170 (120...220)	250 (180...310)	350 (250...460)	500 (380...630)
at $-V_{CE} = 1\text{ V}$, $-I_C = 10\text{ mA}$	h_{FE}	180 (> 80)	260 (120...400)	360 (160...630)	500 (240...1000)
at $-V_{CE} = 1\text{ V}$, $-I_C = 100\text{ mA}$	h_{FE}	> 40	> 45	> 60	> 60

Base emitter voltage

at $-V_{CE} = 5\text{ V}$, $-I_C = 10\text{ }\mu\text{A}$	$-V_{BE}$	0.55	V
at $-V_{CE} = 5\text{ V}$, $-I_C = 2\text{ mA}$	$-V_{BE}$	0.65 (0.6...0.75)	V
at $-V_{CE} = 1\text{ V}$, $-I_C = 10\text{ mA}$	$-V_{BE}$	0.68	V
at $-V_{CE} = 1\text{ V}$, $-I_C = 100\text{ mA}$	$-V_{BE}$	0.75	V

Collector saturation voltage

at $-I_C = 10\text{ mA}$, $-I_B = 0.25\text{ mA}$	$-V_{CE\text{ sat}}$	0.12 (0.06...0.25)	V
at $-I_C = 100\text{ mA}$, $-I_B = 2.5\text{ mA}$	$-V_{CE\text{ sat}}$	0.4 (0.2...0.8)	V

Base saturation voltage

at $-I_C = 10\text{ mA}$, $-I_B = 0.25\text{ mA}$	$-V_{BE\text{ sat}}$	0.7 (0.6...0.85)	V
at $-I_C = 100\text{ mA}$, $-I_B = 2.5\text{ mA}$	$-V_{BE\text{ sat}}$	0.85 (0.7...1.2)	V

		BCY 78	BCY 79	
Collector cutoff current				
at $-V_{CES} = 25\text{ V}$	$-I_{CES}$	2 (< 20)	—	nA
at $-V_{CES} = 35\text{ V}$	$-I_{CES}$	—	2 (< 20)	nA
at $-V_{CES} = 32\text{ V}$	$-I_{CES}$	< 100	—	nA
at $-V_{CES} = 45\text{ V}$	$-I_{CES}$	—	< 100	nA
at $-V_{CES} = 25\text{ V}$, $T_{amb} = 150\text{ }^\circ\text{C}$	$-I_{CES}$	< 10	—	μA
at $-V_{CES} = 35\text{ V}$, $T_{amb} = 150\text{ }^\circ\text{C}$	$-I_{CES}$	—	< 10	μA
at $-V_{CE} = 32\text{ V}$, $-V_{BE} = 0.2\text{ V}$, $T_{amb} = 100\text{ }^\circ\text{C}$	$-I_{CEV}$	< 20	—	μA
at $-V_{CE} = 45\text{ V}$, $-V_{BE} = 0.2\text{ V}$, $T_{amb} = 100\text{ }^\circ\text{C}$	$-I_{CEV}$	—	< 20	μA
Emitter cutoff current				
at $-V_{EBO} = 4\text{ V}$	$-I_{EBO}$	< 20	< 20	nA
Collector emitter breakdown voltage				
at $-I_C = 10\text{ }\mu\text{A}$	$-V_{(BR)CEO}$	> 32	> 45	V
at $-I_C = 10\text{ }\mu\text{A}$	$-V_{(BR)CES}$	> 32	> 45	V
Emitter base breakdown voltage				
at $-I_E = 1\text{ }\mu\text{A}$	$-V_{(BR)EBO}$	> 5	> 5	V

BCY 78, BCY 79

Gain bandwidth product
at $-V_{CE} = 5\text{ V}$, $-I_C = 10\text{ mA}$,
 $f = 100\text{ MHz}$

Collector base capacitance
at $-V_{CB0} = 10\text{ V}$, $f = 1\text{ MHz}$

Emitter base capacitance
at $-V_{EB0} = 0.5\text{ V}$, $f = 1\text{ MHz}$

Noise figure
at $-V_{CE} = 5\text{ V}$, $-I_C = 0.2\text{ mA}$,
 $R_G = 2\text{ k}\Omega$, $f = 1\text{ kHz}$, $\Delta f = 200\text{ Hz}$

Thermal resistance
Junction to ambient air
Junction to case

f_T	180	MHz
C_{CB0}	4.5 (< 7)	pF
C_{EB0}	11 (< 15)	pF
F	2 (< 6)	dB
R_{thA}	< 450	$^{\circ}\text{C/W}$
R_{thC}	< 150	$^{\circ}\text{C/W}$

Switching Times

Test conditions:

$-I_C : -I_{B1} : I_{B2} \approx 10 : 1 : 1\text{ mA}$,

$R_1 = 5\text{ k}\Omega$, $R_2 = 5\text{ k}\Omega$, $R_L = 990\text{ }\Omega$, $V_{BB} = 3.6\text{ V}$

Delay time	t_d	35	ns
Rise time	t_r	50	ns
Turn-on time	t_{on}	85 (< 150)	ns
Storage time	t_s	400	ns
Fall time	t_f	80	ns
Turn-off time	t_{off}	480 (< 800)	ns

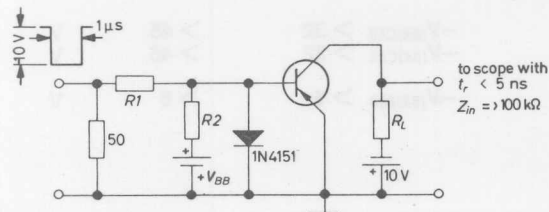
Test conditions:

$-I_C : -I_{B1} : I_{B2} \approx 100 : 10 : 10\text{ mA}$,

$R_1 = 500\text{ }\Omega$, $R_2 = 700\text{ }\Omega$, $R_L = 98\text{ }\Omega$, $V_{BB} = 5\text{ V}$

Delay time	t_d	5	ns
Rise time	t_r	50	ns
Turn-on time	t_{on}	55 (< 150)	ns
Storage time	t_s	250	ns
Fall time	t_f	200	ns
Turn-off time	t_{off}	450 (< 800)	ns

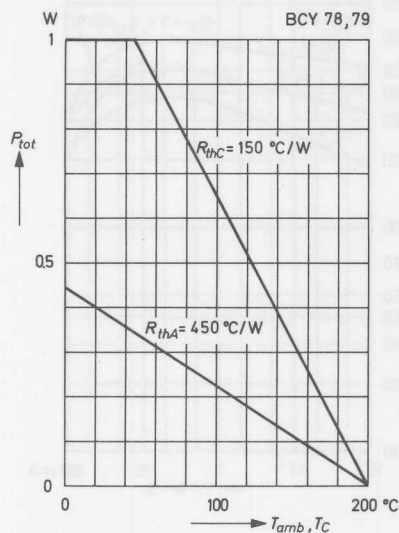
Test Circuit for Switching Times



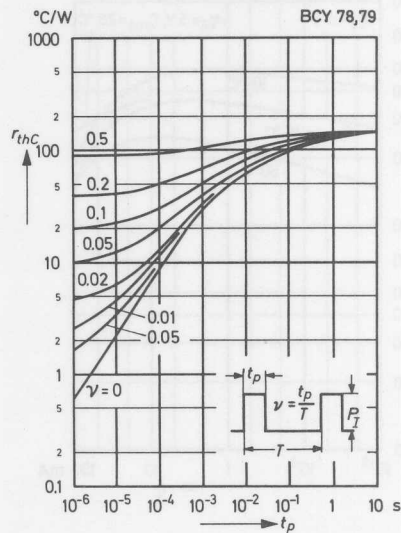
Rise time of input voltage < 5 ns; pulse duty factor < 1 %, generator impedance 50 Ω

BCY 78, BCY 79

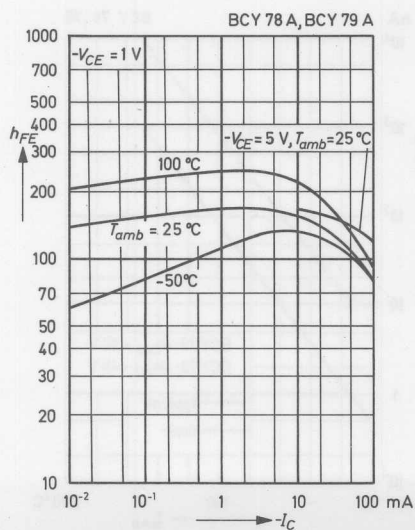
**Admissible power dissipation
versus temperature**



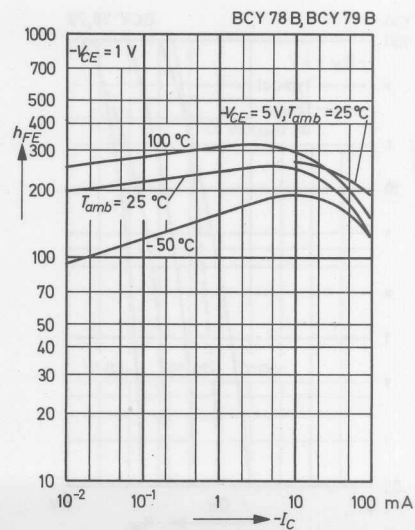
**Pulse thermal resistance
versus pulse duration**



**DC current gain
versus collector current**

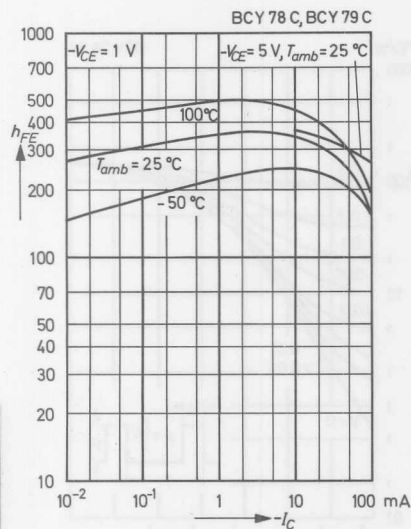


**DC current gain
versus collector current**

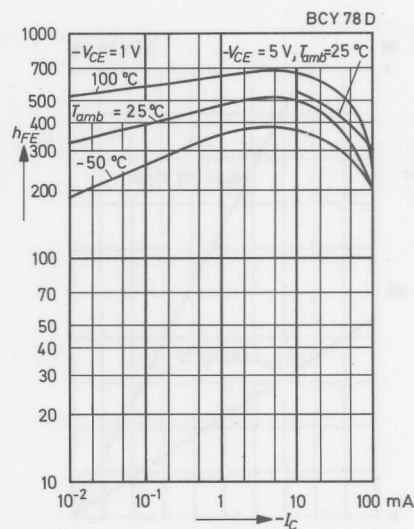


BCY 78, BCY 79

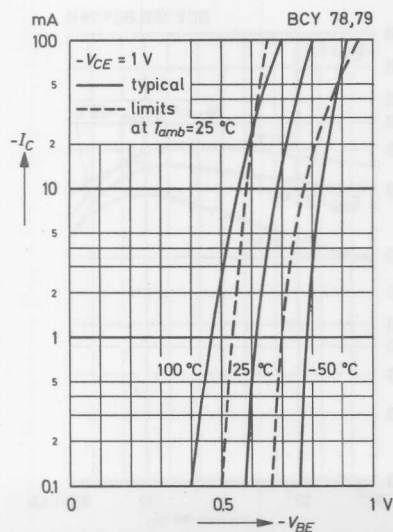
DC current gain
versus collector current



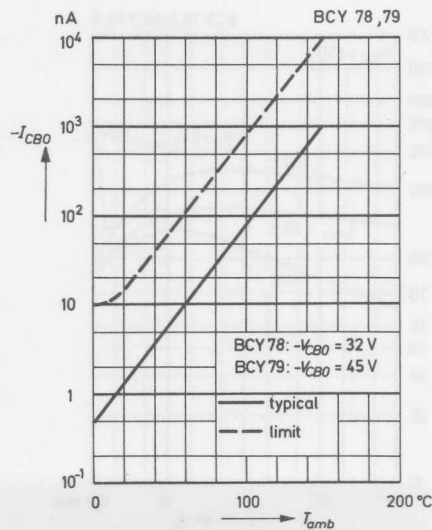
DC current gain
versus collector current



Collector current versus
base emitter voltage

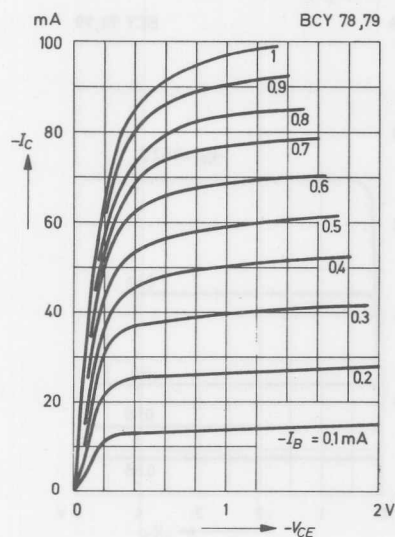


Collector cutoff current
versus ambient temperature

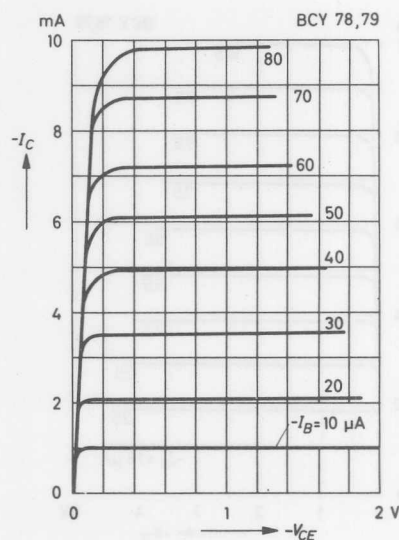


BCY 78, BCY 79

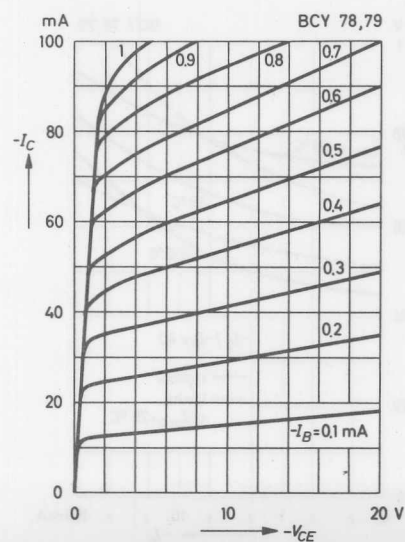
Common emitter
collector characteristics



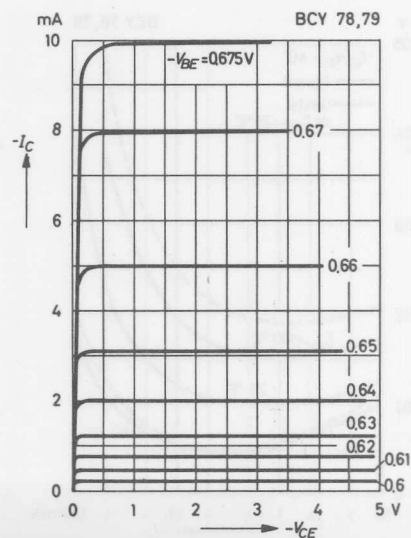
Common emitter
collector characteristics



Common emitter
collector characteristics

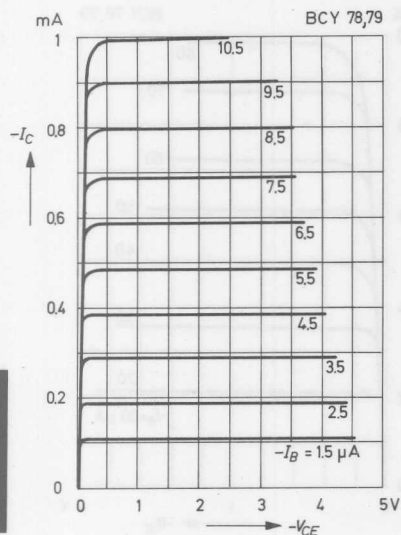


Common emitter
collector characteristics

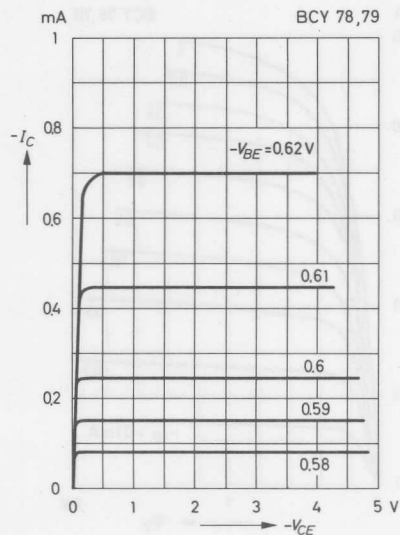


BCY 78, BCY 79

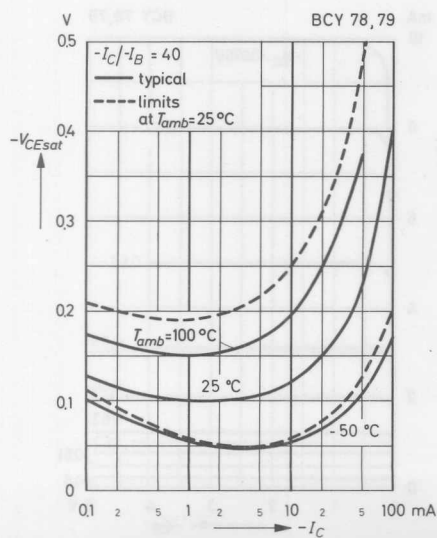
Common emitter
collector characteristics



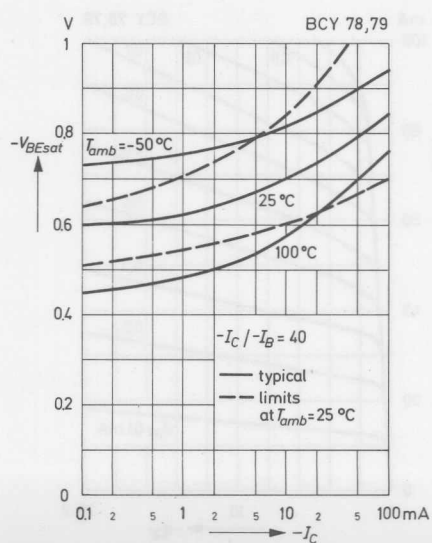
Common emitter
collector characteristics



Collector saturation voltage
versus collector current

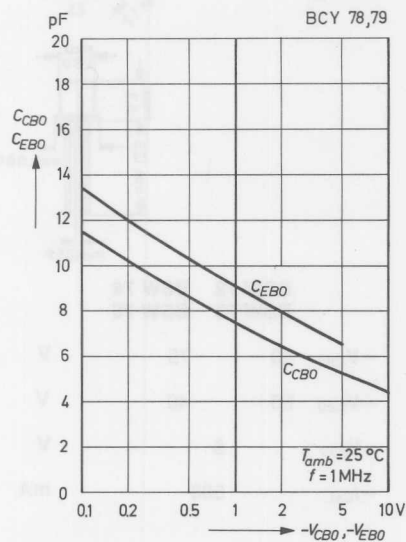


Base saturation voltage
versus collector current

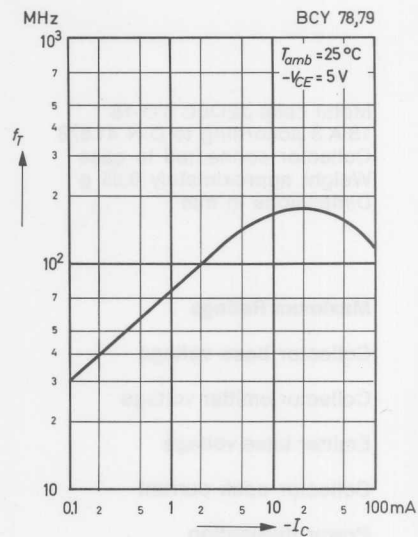


BCY 78, BCY 79

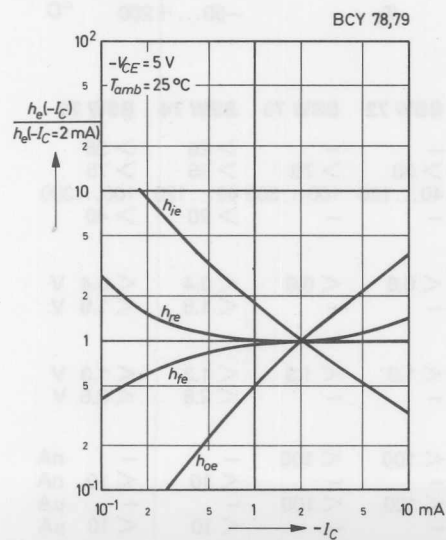
Collector base capacitance,
Emitter base capacitance
versus reverse bias voltage



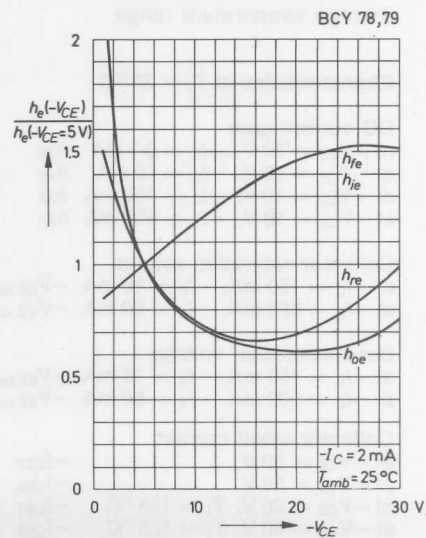
Gain bandwidth product
versus collector current



Relative h -parameters
versus
collector current



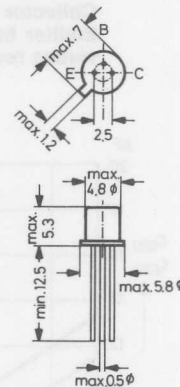
Relative h -parameters
versus
collector emitter voltage



BSW 72, BSW 73, BSW 74, BSW 75

PNP Silicon Epitaxial Planar Transistors
with high cutoff frequency, for high speed switching

Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm



Maximum Ratings

	BSW 72	BSW 73	BSW 74	BSW 75
Collector base voltage	$-V_{CB0}$	40	75	V
Collector emitter voltage	$-V_{CE0}$	25	40	V
Emitter base voltage	$-V_{EB0}$	5		V
Collector peak current	$-I_{CM}$	500		mA
Power dissipation				
at $T_{amb} = 25^{\circ}\text{C}$	P_{tot}	400		mW
at $T_C = 25^{\circ}\text{C}$	P_{tot}	1.8		W
Junction temperature	T_j	200		$^{\circ}\text{C}$
Storage temperature range	T_s	-50...+200		$^{\circ}\text{C}$

Characteristics at $T_j = 25^{\circ}\text{C}$

	BSW 72	BSW 73	BSW 74	BSW 75
DC current gain				
at $-V_{CE} = 10\text{ V}$, $-I_C = 0.1\text{ mA}$	h_{FE}	—	> 20	> 35
at $-V_{CE} = 10\text{ V}$, $-I_C = 10\text{ mA}$	h_{FE}	> 30	> 70	> 35
at $-V_{CE} = 10\text{ V}$, $-I_C = 150\text{ mA}$	h_{FE}	40...120	100...300	40...120
at $-V_{CE} = 10\text{ V}$, $-I_C = 500\text{ mA}$	h_{FE}	—	—	> 20
Collector saturation voltage				
at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$	$-V_{CE sat}$	< 0.6	< 0.6	< 0.4
at $-I_C = 500\text{ mA}$, $-I_B = 50\text{ mA}$	$-V_{CE sat}$	—	—	< 1.6
Base saturation voltage				
at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$	$-V_{BE sat}$	< 1.3	< 1.3	< 1.3
at $-I_C = 500\text{ mA}$, $-I_B = 50\text{ mA}$	$-V_{BE sat}$	—	—	< 2.6
Collector cutoff current				
at $-V_{CB} = 30\text{ V}$	$-I_{CB0}$	< 100	< 100	—
at $-V_{CB} = 50\text{ V}$	$-I_{CB0}$	—	—	< 10
at $-V_{CB} = 30\text{ V}$, $T_j = 125^{\circ}\text{C}$	$-I_{CB0}$	< 100	< 100	—
at $-V_{CB} = 50\text{ V}$, $T_j = 125^{\circ}\text{C}$	$-I_{CB0}$	—	—	< 10

BSW 72, BSW 73, BSW 74, BSW 75

Emitter cutoff current
at $-V_{EB} = 3 \text{ V}$

$-I_{EB0} < 100 \text{ nA}$

Gain bandwidth product
at $-V_{CE} = 20 \text{ V}$, $-I_C = 50 \text{ mA}$,
 $f = 100 \text{ MHz}$

$f_T > 150 \text{ MHz}$

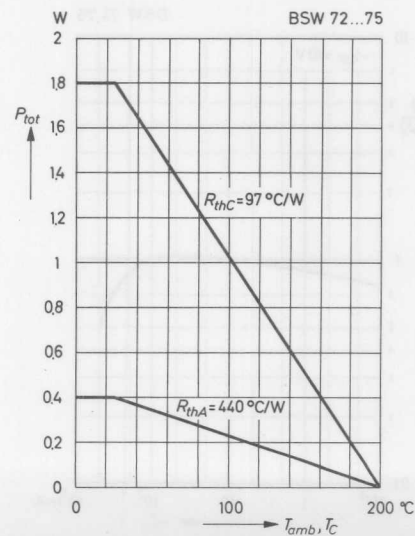
Collector base capacitance
at $-V_{CB0} = 10 \text{ V}$, $f = 100 \text{ kHz}$

$C_{CB0} < 8 \text{ pF}$

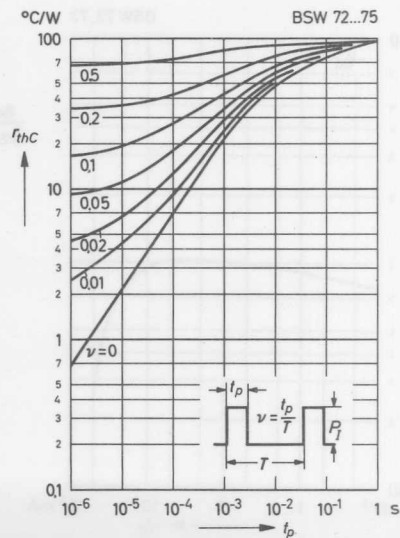
Thermal resistance
Junction to ambient air
Junction to case

$R_{thA} < 440 \text{ }^\circ\text{C/W}$
 $R_{thC} < 97 \text{ }^\circ\text{C/W}$

Admissible power dissipation
versus temperature

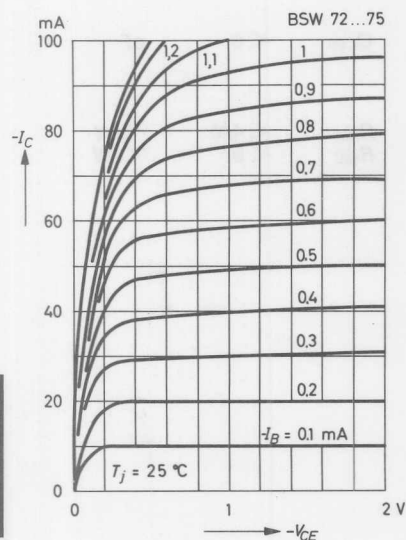


Pulse thermal resistance
versus pulse duration

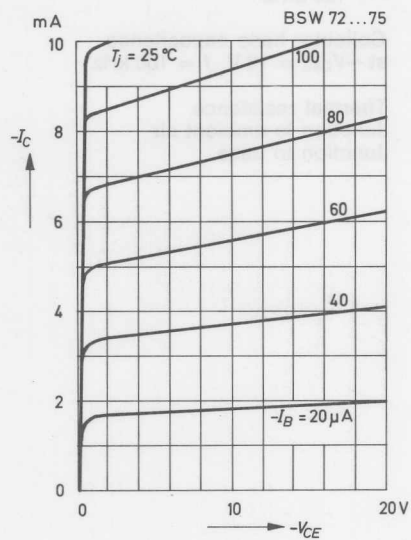


BSW 72, BSW 73, BSW 74, BSW 75

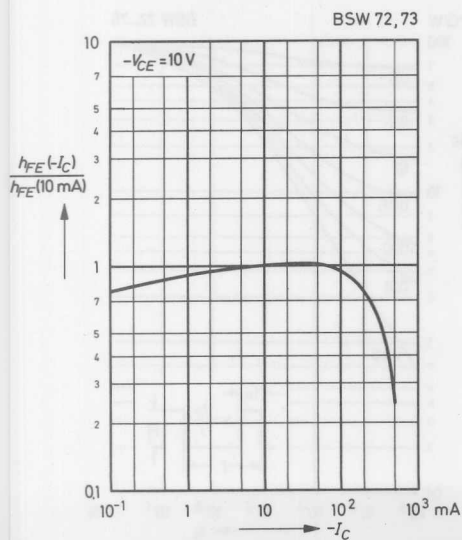
Common emitter
Collector characteristics



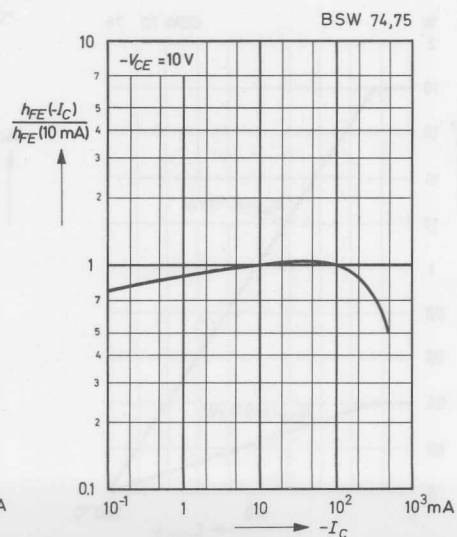
Common emitter
collector characteristics



Relative DC current gain
versus collector current

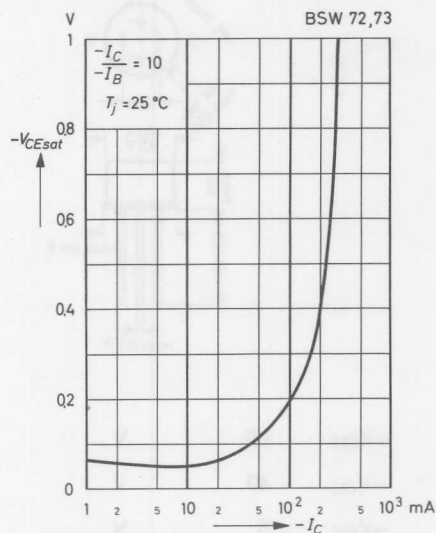


Relative DC current gain
versus collector current

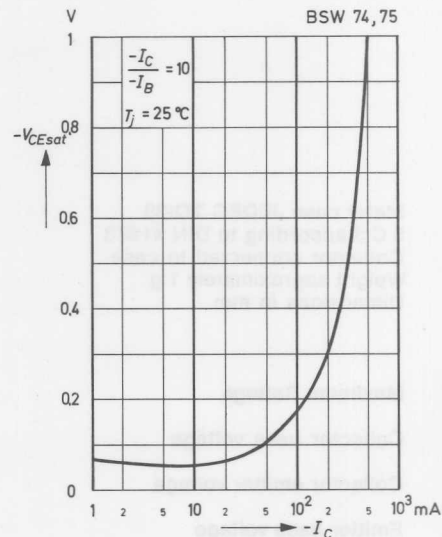


BSW 72, BSW 73, BSW 74, BSW 75

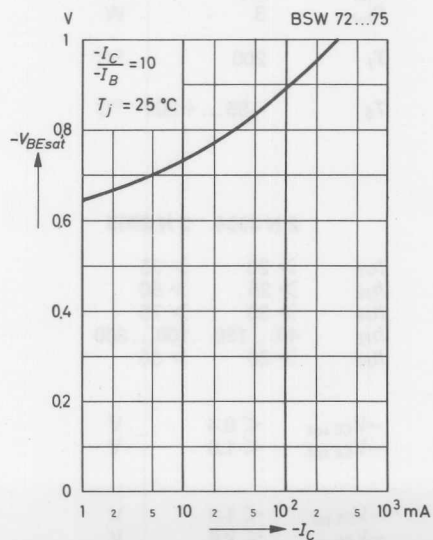
Collector saturation voltage
versus collector current



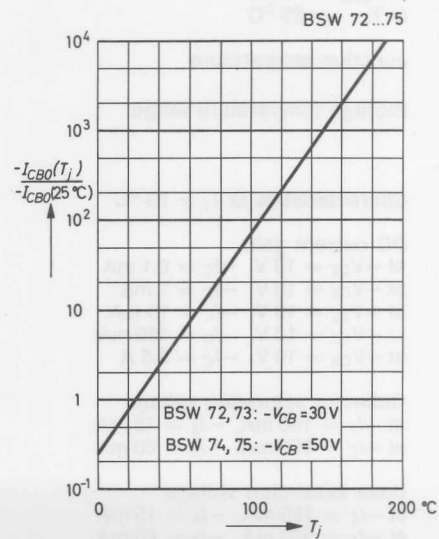
Collector saturation voltage
versus collector current



Base saturation voltage
versus collector current



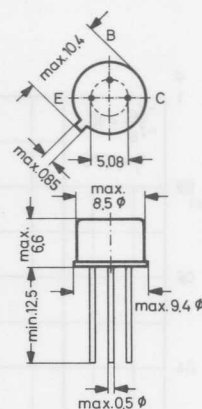
Collector cutoff current
versus junction temperature



2 N 2904, 2 N 2905

PNP Silicon Epitaxial Planar Transistors
with high cutoff frequency, for high speed switching

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	$-V_{CB0}$	60	V
Collector emitter voltage	$-V_{CE0}$	40	V
Emitter base voltage	$-V_{EB0}$	5	V
Collector current	$-I_C$	0.6	A
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 25^\circ\text{C}$	P_{tot}	3	W
Junction temperature	T_j	200	$^\circ\text{C}$
Storage temperature range	T_S	-65...+200	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $-V_{CE} = 10\text{ V}$, $-I_C = 0.1\text{ mA}$
at $-V_{CE} = 10\text{ V}$, $-I_C = 1\text{ mA}$
at $-V_{CE} = 10\text{ V}$, $-I_C = 10\text{ mA}$
at $-V_{CE} = 10\text{ V}$, $-I_C = 150\text{ mA}$
at $-V_{CE} = 10\text{ V}$, $-I_C = 0.5\text{ A}$

Collector saturation voltage

at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$
at $-I_C = 500\text{ mA}$, $-I_B = 50\text{ mA}$

Base saturation voltage

at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$
at $-I_C = 500\text{ mA}$, $-I_B = 50\text{ mA}$

2 N 2904 2 N 2905

h_{FE}	> 20	> 35
h_{FE}	> 25	> 50
h_{FE}	> 35	> 75
h_{FE}	40...120	100...300
h_{FE}	> 20	> 30

$-V_{CE\text{ sat}}$	< 0.4	V
$-V_{CE\text{ sat}}$	< 1.6	V

$-V_{BE\text{ sat}}$	< 1.3	V
$-V_{BE\text{ sat}}$	< 2.6	V

Collector cutoff current

at $-V_{CB} = 50 \text{ V}$ at $-V_{CB} = 50 \text{ V}$, $T_{amb} = 150^\circ\text{C}$ at $-V_{CE} = 30 \text{ V}$, $-V_{EB} = 0.5 \text{ V}$

$$-I_{CB0} < 20 \text{ nA}$$

$$-I_{CB0} < 20 \text{ }\mu\text{A}$$

$$-I_{CEV} < 50 \text{ nA}$$

Base cutoff current

at $-V_{CE} = 30 \text{ V}$, $-V_{EB} = 0.5 \text{ V}$

$$-I_{EBV} < 50 \text{ nA}$$

Collector base breakdown voltage

at $-I_C = 10 \text{ }\mu\text{A}$

$$-V_{(BR)CB0} > 60 \text{ V}$$

Collector emitter breakdown voltage

at $-I_C = 10 \text{ mA}$

$$-V_{(BR)CE0} > 40 \text{ V}$$

Emitter base breakdown voltage

at $-I_E = 10 \text{ }\mu\text{A}$

$$-V_{(BR)EB0} > 5 \text{ V}$$

Gain bandwidth product

at $-V_{CE} = 20 \text{ V}$, $-I_C = 50 \text{ mA}$, $f = 100 \text{ MHz}$

$$f_T > 200 \text{ MHz}$$

Collector base capacitance

at $-V_{CB0} = 10 \text{ V}$, $f = 100 \text{ kHz}$

$$C_{CB0} < 8 \text{ pF}$$

Emitter base capacitance

at $-V_{EB0} = 2 \text{ V}$, $f = 100 \text{ kHz}$

$$C_{EB0} < 30 \text{ pF}$$

Thermal resistance

Junction to ambient air

$$R_{thA} < 220 \text{ }^\circ\text{C/W}$$

Junction to case

$$R_{thC} < 58 \text{ }^\circ\text{C/W}$$

Switching Times

Delay time (see Fig. 1)

$$t_d \quad 6 (< 10) \text{ ns}$$

Rise time (see Fig. 1)

$$t_r \quad 20 (< 40) \text{ ns}$$

Turn-on time (see Fig. 1)

$$t_{on} \quad 26 (< 45) \text{ ns}$$

Storage time (see Fig. 2)

$$t_s \quad 50 (< 80) \text{ ns}$$

Fall time (see Fig. 2)

$$t_f \quad 20 (< 30) \text{ ns}$$

Turn-off time (see Fig. 2)

$$t_{off} \quad 70 (< 100) \text{ ns}$$

Total switching time (see Fig. 3)

$$t_{total} \quad 12 \text{ ns}$$

Curves and characteristics of types BSW 72...75 are valid analogously for types 2 N 2904 and 2 N 2905.

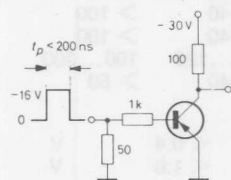


Fig. 1: Test circuit for turn-on time, saturated operation

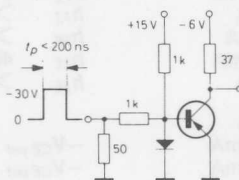


Fig. 2: Test circuit for turn-off time, saturated operation

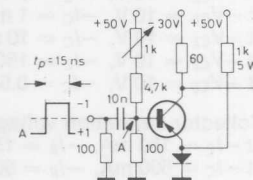
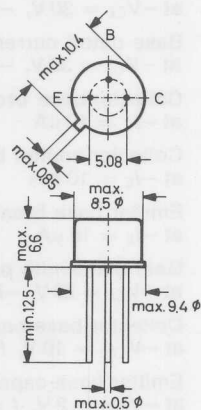


Fig. 3: Test circuit for non-saturated operation

2 N 2904 A, 2 N 2905 A

PNP Silicon Epitaxial Planar Transistors
with high cutoff frequency, for high speed switching

Metal case JEDEC TO-39
5 C 3 according to DIN 41873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	$-V_{CB0}$	60	V
Collector emitter voltage	$-V_{CE0}$	60	V
Emitter base voltage	$-V_{EB0}$	5	V
Collector current	$-I_C$	0.6	A
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 25^\circ\text{C}$	P_{tot}	3	W
Junction temperature	T_j	200	$^\circ\text{C}$
Storage temperature range	T_S	-65...+200	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

	2 N 2904 A	2 N 2905 A
at $-V_{CE} = 10\text{ V}$, $-I_C = 0.1\text{ mA}$	$h_{FE} > 40$	> 75
at $-V_{CE} = 10\text{ V}$, $-I_C = 1\text{ mA}$	$h_{FE} > 40$	> 100
at $-V_{CE} = 10\text{ V}$, $-I_C = 10\text{ mA}$	$h_{FE} > 40$	> 100
at $-V_{CE} = 10\text{ V}$, $-I_C = 150\text{ mA}$	$h_{FE} 40 \dots 120$	$100 \dots 300$
at $-V_{CE} = 10\text{ V}$, $-I_C = 0.5\text{ A}$	$h_{FE} > 40$	> 50

Collector saturation voltage

at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$	$-V_{CE sat}$	< 0.4	V
at $-I_C = 500\text{ mA}$, $-I_B = 50\text{ mA}$	$-V_{CE sat}$	< 1.6	V

Base saturation voltage

at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$	$-V_{BE sat}$	< 1.3	V
at $-I_C = 500\text{ mA}$, $-I_B = 50\text{ mA}$	$-V_{BE sat}$	< 2.6	V

2 N 2904 A, 2 N 2905 A

Collector cutoff current			
at $-V_{CB} = 50 \text{ V}$	$-I_{CB0}$	< 10	nA
at $-V_{CB} = 50 \text{ V}$, $T_{amb} = 150^\circ\text{C}$	$-I_{CB0}$	< 10	μA
at $-V_{CE} = 30 \text{ V}$, $-V_{EB} = 0.5 \text{ V}$	$-I_{CEV}$	< 50	nA
Base cutoff current	$-I_{EBV}$	< 50	nA
at $-V_{CE} = 30 \text{ V}$, $-V_{EB} = 0.5 \text{ V}$			
Collector base breakdown voltage	$-V_{(BR)CB0}$	> 60	V
at $-I_C = 10 \mu\text{A}$			
Collector emitter breakdown voltage	$-V_{(BR)CE0}$	> 60	V
at $-I_C = 10 \text{ mA}$			
Emitter base breakdown voltage	$-V_{(BR)EB0}$	> 5	V
at $-I_E = 10 \mu\text{A}$			
Gain bandwidth product	f_T	> 200	MHz
at $-V_{CE} = 20 \text{ V}$, $-I_C = 50 \text{ mA}$, $f = 100 \text{ MHz}$			
Collector base capacitance	C_{CB0}	< 8	pF
at $-V_{CB} = 10 \text{ V}$, $f = 100 \text{ kHz}$			
Emitter base capacitance	C_{EB0}	< 30	pF
at $-V_{EB} = 2 \text{ V}$, $f = 100 \text{ kHz}$			
Thermal resistance			
Junction to ambient air	R_{thA}	< 220	$^\circ\text{C/W}$
Junction to case	R_{thC}	< 58	$^\circ\text{C/W}$

Curves and characteristics of types BSW 72...75 are valid analogously for types 2 N 2904 A and 2 N 2905 A.

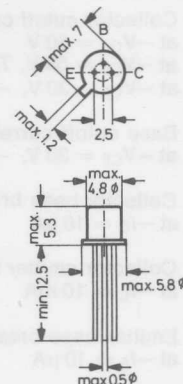
Switching Times

Specifications for switching times of types 2 N 2904 and 2 N 2905 resp. apply to these types.

2 N 2906, 2 N 2907

PNP Silicon Epitaxial Planar Transistors
with high cutoff frequency, for high speed switching

Metal case JEDEC TO-18
18 A 3 according to DIN 41876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm



Maximum Ratings

Collector base voltage	$-V_{CB0}$	60	V
Collector emitter voltage	$-V_{CE0}$	40	V
Emitter base voltage	$-V_{EB0}$	5	V
Collector current	$-I_C$	0.6	A
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.4	W
at $T_C = 25^\circ\text{C}$	P_{tot}	1.8	W
Junction temperature	T_j	200	$^\circ\text{C}$
Storage temperature range	T_S	$-65 \dots +200^\circ\text{C}$	

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $-V_{CE} = 10\text{ V}$, $-I_C = 0.1\text{ mA}$
at $-V_{CE} = 10\text{ V}$, $-I_C = 1\text{ mA}$
at $-V_{CE} = 10\text{ V}$, $-I_C = 10\text{ mA}$
at $-V_{CE} = 10\text{ V}$, $-I_C = 150\text{ mA}$
at $-V_{CE} = 10\text{ V}$, $-I_C = 0.5\text{ A}$

	2 N 2906	2 N 2907
h_{FE}	> 20	> 35
h_{FE}	> 25	> 50
h_{FE}	> 35	> 75
h_{FE}	40 ... 120	100 ... 300
h_{FE}	> 20	> 30

Collector saturation voltage

at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$
at $-I_C = 500\text{ mA}$, $-I_B = 50\text{ mA}$

$-V_{CE\text{ sat}}$	< 0.4	V
$-V_{CE\text{ sat}}$	< 1.6	V

Base saturation voltage

at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$
at $-I_C = 500\text{ mA}$, $-I_B = 50\text{ mA}$

$-V_{BE\text{ sat}}$	< 1.3	V
$-V_{BE\text{ sat}}$	< 2.6	V

Collector cutoff current at $-V_{CB} = 50 \text{ V}$	$-I_{CB0}$	< 20	nA
at $-V_{CB} = 50 \text{ V}$, $T_{amb} = 150^\circ\text{C}$	$-I_{CB0}$	< 20	μA
at $-V_{CE} = 30 \text{ V}$, $-V_{EB} = 0.5 \text{ V}$	$-I_{CEV}$	< 50	nA
Base cutoff current at $-V_{CE} = 30 \text{ V}$, $-V_{EB} = 0.5 \text{ V}$	$-I_{EBV}$	< 50	nA
Collector base breakdown voltage at $-I_C = 10 \mu\text{A}$	$-V_{(BR)CB0}$	> 60	V
Collector emitter breakdown voltage at $-I_C = 10 \text{ mA}$	$-V_{(BR)CE0}$	> 40	V
Emitter base breakdown voltage at $-I_E = 10 \mu\text{A}$	$-V_{(BR)EB0}$	> 5	V
Gain bandwidth product at $-V_{CE} = 20 \text{ V}$, $-I_C = 50 \text{ mA}$, $f = 100 \text{ MHz}$	f_T	> 200	MHz
Collector base capacitance at $-V_{CB} = 10 \text{ V}$, $f = 100 \text{ kHz}$	C_{CB0}	< 8	pF
Emitter base capacitance at $-V_{EB} = 2 \text{ V}$, $f = 100 \text{ kHz}$	C_{EB0}	< 30	pF
Thermal resistance Junction to ambient air	R_{thA}	< 440	$^\circ\text{C/W}$
Junction to case	R_{thC}	< 97	$^\circ\text{C/W}$

Curves and characteristics of types BSW 72...75 are valid analogously for types 2 N 2906 and 2 N 2907.

Switching Times

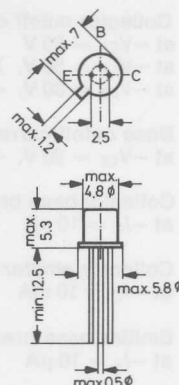
Specifications for switching times of types 2 N 2904 and 2 N 2905 resp. apply to these types.

2 N 2906 A, 2 N 2907 A

PNP Silicon Epitaxial Planar Transistors

with high cutoff frequency, for high speed switching

Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm



Maximum Ratings

Collector base voltage	$-V_{CB0}$	60	V
Collector emitter voltage	$-V_{CE0}$	60	V
Emitter base voltage	$-V_{EB0}$	5	V
Collector current	$-I_C$	0.6	A
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.4	W
at $T_C = 25^\circ\text{C}$	P_{tot}	1.8	W
Junction temperature	T_j	200	$^\circ\text{C}$
Storage temperature range	T_S	$-65 \dots +200$	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

at $-V_{CE} = 10\text{ V}$, $-I_C = 0.1\text{ mA}$
at $-V_{CE} = 10\text{ V}$, $-I_C = 1\text{ mA}$
at $-V_{CE} = 10\text{ V}$, $-I_C = 10\text{ mA}$
at $-V_{CE} = 10\text{ V}$, $-I_C = 150\text{ mA}$
at $-V_{CE} = 10\text{ V}$, $-I_C = 0.5\text{ A}$

	2 N 2906 A	2 N 2907 A
h_{FE}	> 40	> 75
h_{FE}	> 40	> 100
h_{FE}	> 40	> 100
h_{FE}	$40 \dots 120$	$100 \dots 300$
h_{FE}	> 40	> 50

Collector saturation voltage

at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$
at $-I_C = 500\text{ mA}$, $-I_B = 50\text{ mA}$

$-V_{CE\text{ sat}}$	< 0.4	V
$-V_{CE\text{ sat}}$	< 1.6	V

Base saturation voltage

at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$
at $-I_C = 500\text{ mA}$, $-I_B = 50\text{ mA}$

$-V_{BE\text{ sat}}$	< 1.3	V
$-V_{BE\text{ sat}}$	< 2.6	V

Collector cutoff current

at $-V_{CB} = 50 \text{ V}$	$-I_{CB0}$	< 10	nA
at $-V_{CB} = 50 \text{ V}$, $T_{amb} = 150^\circ\text{C}$	$-I_{CB0}$	< 10	μA
at $-V_{CE} = 30 \text{ V}$, $-V_{EB} = 0.5 \text{ V}$	$-I_{CEV}$	< 50	nA

Base cutoff current

at $-V_{CE} = 30 \text{ V}$, $-V_{EB} = 0.5 \text{ V}$	$-I_{EBV}$	< 50	nA
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Collector base breakdown voltage
at $-I_C = 10 \mu\text{A}$

$-V_{(BR)CB0}$	> 60	V
----------------	--------	---

Collector emitter breakdown voltage
at $-I_C = 10 \text{ mA}$

$-V_{(BR)CE0}$	> 60	V
----------------	--------	---

Emitter base breakdown voltage
at $-I_E = 10 \mu\text{A}$

$-V_{(BR)EB0}$	> 5	V
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Gain bandwidth product

at $-V_{CE} = 20 \text{ V}$, $-I_C = 50 \text{ mA}$, $f = 100 \text{ MHz}$	f_T	> 200	MHz
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Collector base capacitance
at $-V_{CB} = 10 \text{ V}$, $f = 100 \text{ kHz}$

C_{CB0}	< 8	pF
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Emitter base capacitance
at $-V_{EB} = 2 \text{ V}$, $f = 100 \text{ kHz}$

C_{EB0}	< 30	pF
-----------	--------	----

Thermal resistance

Junction to ambient air

R_{thA}	< 440	$^\circ\text{C/W}$
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Junction to case

R_{thC}	< 97	$^\circ\text{C/W}$
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Curves and characteristics of types BSW 72...75 are valid analogously for types 2 N 2906 A and 2 N 2907 A.

Switching Times

Specifications for switching times of types 2 N 2904 and 2 N 2905 resp. apply to these types.

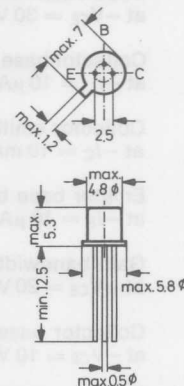
2 N 3962, 2 N 3963, 2 N 3964

PNP Silicon Planar Transistors

designed for use in high-performance, low level, low noise amplifiers from audio to high frequency ranges. These units feature excellent DC current gain linearity from 1 μ A to 50 mA.

Type 2 N 3964 offers extremely small low-frequency noise figures over a wide range of source impedances.

Metal case JEDEC TO-18
18 A 3 according to DIN 41876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm



Maximum Ratings

		2 N 3962	2 N 3963	2 N 3964	
Collector base voltage	$-V_{CB0}$	60	80	45	V
Collector emitter voltage	$-V_{CE0}$	60	80	45	V
Emitter base voltage	$-V_{EB0}$	6	6	6	V
Power dissipation					W
at $T_{amb} = 25^{\circ}\text{C}$	P_{tot}		0.36		W
at $T_C = 25^{\circ}\text{C}$	P_{tot}		1.2		W
Junction temperature	T_j		200		$^{\circ}\text{C}$
Storage temperature range	T_S		-65 ... +200		$^{\circ}\text{C}$

Static characteristics at $T_j = 25^{\circ}\text{C}$

		2 N 3962 2 N 3963	2 N 3964
DC current gain			
at $-V_{CE} = 5\text{ V}$, $-I_C = 1\text{ }\mu\text{A}$	h_{FE}	175 (> 60)	300 (> 180)
at $-V_{CE} = 5\text{ V}$, $-I_C = 10\text{ }\mu\text{A}$	h_{FE}	210 (100 ... 300)	320 (250 ... 500)
at $-V_{CE} = 5\text{ V}$, $-I_C = 100\text{ }\mu\text{A}$	h_{FE}	240 (> 100)	330 (> 250)
at $-V_{CE} = 5\text{ V}$, $-I_C = 1\text{ mA}$	h_{FE}	260 (100 ... 450)	330 (250 ... 600)
at $-V_{CE} = 5\text{ V}$, $-I_C = 10\text{ mA}$	h_{FE}	280 (> 100)	330 (> 200)
at $-V_{CE} = 5\text{ V}$, $-I_C = 50\text{ mA}$	h_{FE}	260 (> 90)	315 (> 180)
at $-V_{CE} = 5\text{ V}$, $-I_C = 10\text{ }\mu\text{A}$, $T_j = -55^{\circ}\text{C}$	h_{FE}	90 (> 40)	160 (> 100)
at $-V_{CE} = 5\text{ V}$, $-I_C = 50\text{ mA}$, $T_j = -55^{\circ}\text{C}$	h_{FE}	150 (> 45)	190 (> 90)
at $-V_{CE} = 5\text{ V}$, $-I_C = 1\text{ mA}$, $T_j = 100^{\circ}\text{C}$	h_{FE}	375 (< 600)	400 (< 800)

Collector saturation voltage

at $-I_C = 10\text{ mA}$, $-I_B = 0.5\text{ mA}$	$-V_{CE\text{ sat}}$	0.1 (< 0.25)	V
at $-I_C = 50\text{ mA}$, $-I_B = 5\text{ mA}$	$-V_{CE\text{ sat}}$	0.16 (< 0.4)	V

Base saturation voltage

at $-I_C = 10\text{ mA}$, $-I_B = 0.5\text{ mA}$	$-V_{BE\text{ sat}}$	0.72 (< 0.9)	V
at $-I_C = 50\text{ mA}$, $-I_B = 5\text{ mA}$	$-V_{BE\text{ sat}}$	0.81 (< 0.95)	V

2 N 3962, 2 N 3963, 2 N 3964

		2 N 3962	2 N 3963	2 N 3964	
Collector cutoff current					
at $-V_{CE} = 40 \text{ V}$	$-I_{CES}$	—	—	0.5 (< 10)	nA
at $-V_{CE} = 50 \text{ V}$	$-I_{CES}$	0.5 (< 10)	—	—	nA
at $-V_{CE} = 70 \text{ V}$	$-I_{CES}$	—	0.5 (< 10)	—	nA
at $-V_{CE} = 40 \text{ V}$, $T_i = 150^\circ\text{C}$	$-I_{CES}$	—	—	2 (< 10)	μA
at $-V_{CE} = 50 \text{ V}$, $T_i = 150^\circ\text{C}$	$-I_{CES}$	2 (< 10)	—	—	μA
at $-V_{CE} = 70 \text{ V}$, $T_i = 150^\circ\text{C}$	$-I_{CES}$	—	2 (< 10)	—	μA
Emitter cutoff current					
at $-V_{EB} = 4 \text{ V}$	$-I_{EBO}$	< 10	< 10	< 10	nA
Collector base breakdown voltage					
at $-I_C = 10 \mu\text{A}$	$-V_{(BR)CBO}$	> 60	> 80	> 45	V
Collector emitter breakdown voltage					
at $-I_C = 10 \mu\text{A}$	$-V_{(BR)CES}$	> 60	> 80	> 45	V
at $-I_C = 5 \text{ mA}$	$-V_{(BR)CEO}$	> 60	> 80	> 45	V
Emitter base breakdown voltage					
at $-I_E = 10 \mu\text{A}$	$-V_{(BR)EBO}$	> 6	> 6	> 6	V
Thermal resistance					
Junction to ambient air	R_{thA}		< 480		$^\circ\text{C/W}$
Junction to case	R_{thC}		< 150		$^\circ\text{C/W}$

Dynamic characteristics at $T_{amb} = 25^\circ\text{C}$

Collector base capacitance					
at $-V_{CBO} = 5 \text{ V}$	C_{CBO}		< 6		pF
Emitter base capacitance					
at $-V_{EBO} = 0.5 \text{ V}$	C_{EBO}		< 15		pF
Gain bandwidth product					
at $-V_{CE} = 5 \text{ V}$, $-I_C = 0.5 \text{ mA}$, $f = 20 \text{ MHz}$					
2 N 3962 and 2 N 3963	f_T		> 40		MHz
2 N 3964	f_T		> 50		MHz
h -parameters at $-V_{CE} = 5 \text{ V}$, $-I_C = 1 \text{ mA}$, $f = 1 \text{ kHz}$					
		2 N 3962 2 N 3963	2 N 3964		
Small signal current gain					
	h_{fe}	300 (100...550)	360 (250...700)		
Input impedance					
	h_{ie}	8 (2.5...17)	10 (6...20)		k Ω
Output admittance					
	h_{oe}	19 (5...40)	25 (5...50)		μmho
Reverse voltage transfer ratio					
	h_{re}	< $10 \cdot 10^{-4}$	< $10 \cdot 10^{-4}$		

2 N 3962, 2 N 3963, 2 N 3964

2 N 3962 2 N 3964
2 N 3963

Noise figure

at $-V_{CE} = 5\text{ V}$, $-I_C = 20\text{ }\mu\text{A}$, $R_G = 10\text{ k}\Omega$

at $\Delta f = 30\text{ Hz} \dots 15\text{ kHz}$

at $f = 10\text{ Hz}$

at $f = 120\text{ Hz}$

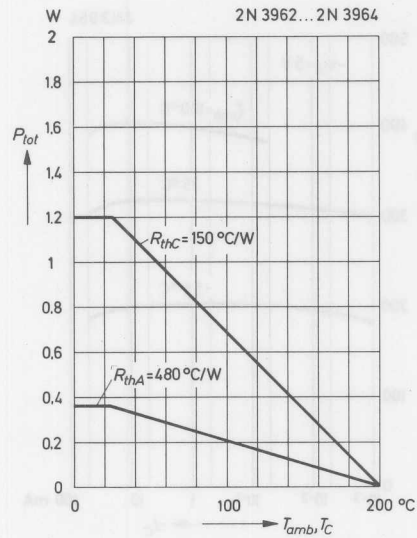
at $f = 1\text{ kHz}$

at $f = 10\text{ kHz}$

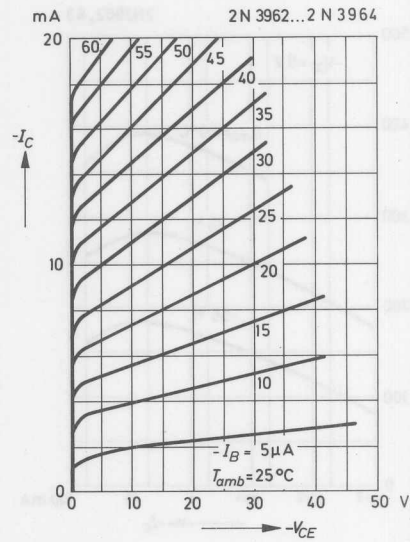
F	1 (< 3)	0.7 (< 2)	dB
F	—	3.5 (< 8)	dB
F	3 (< 10)	1.8 (< 4)	dB
F	0.8 (< 3)	0.5 (< 2)	dB
F	0.8 (< 3)	0.5 (< 2)	dB

2 N 3962, 2 N 3963, 2 N 3964

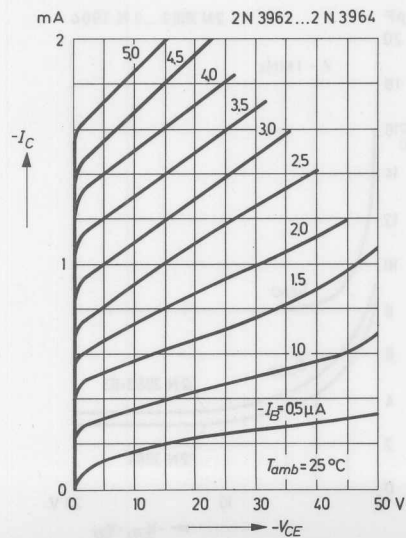
**Admissible power dissipation
versus temperature**



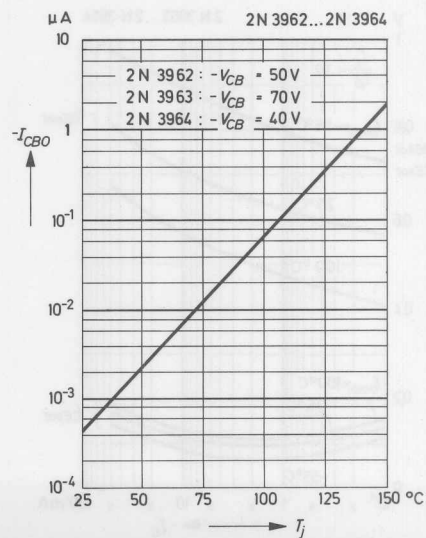
**Common emitter
collector characteristics**



**Common emitter
collector characteristics**

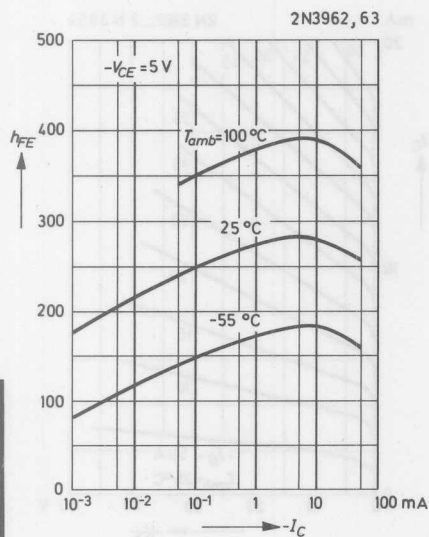


**Collector cutoff current
versus junction temperature**

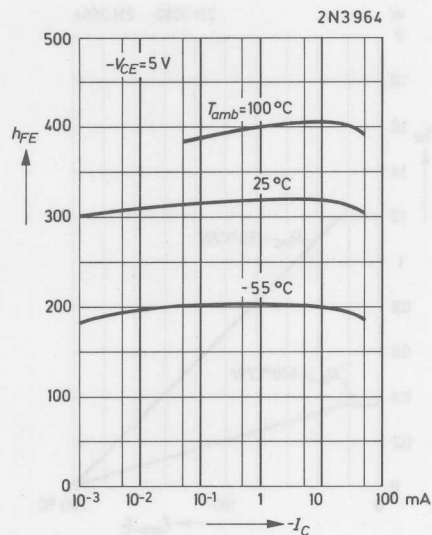


2 N 3962, 2 N 3963, 2 N 3964

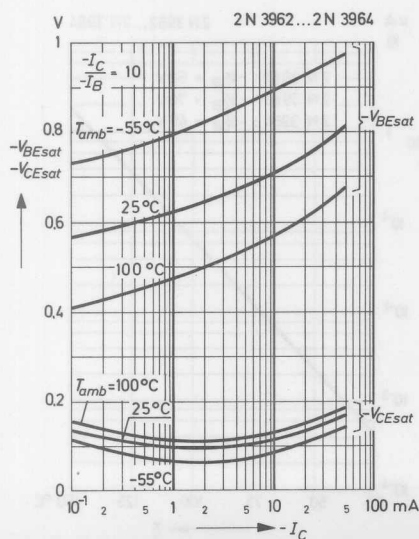
DC current gain
versus collector current



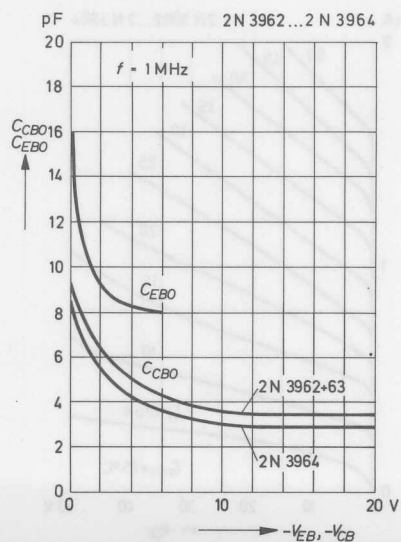
DC current gain
versus collector current



Collector saturation voltage,
Base saturation voltage
versus collector current

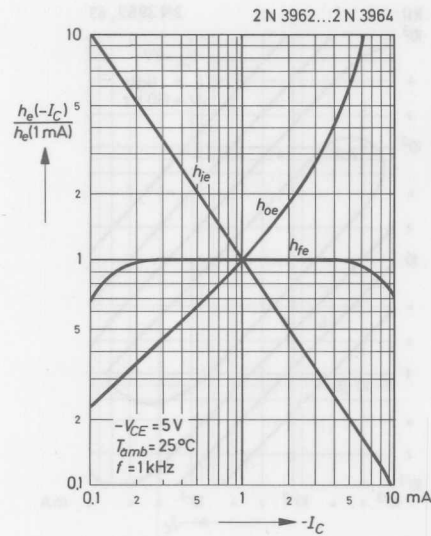


Collector base capacitance,
Emitter base capacitance
versus reverse bias voltage

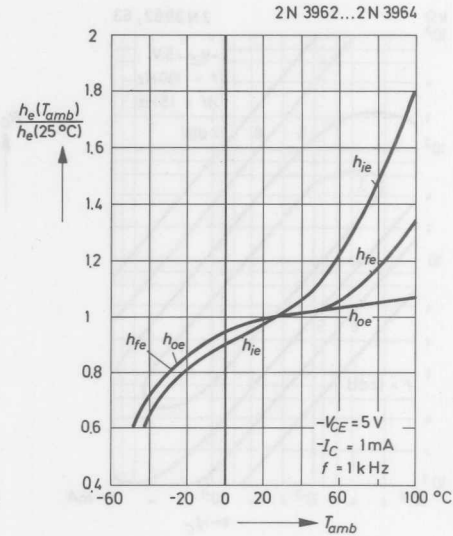


2 N 3962, 2 N 3963, 2 N 3964

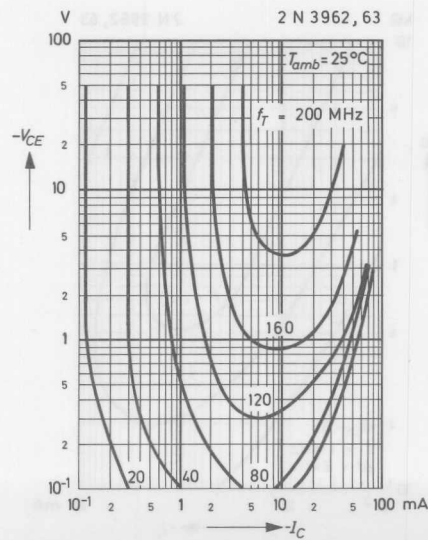
Relative h -parameters
versus collector current



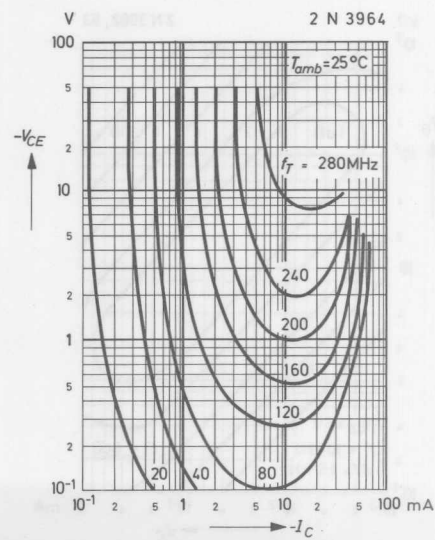
Relative h -parameters
versus ambient temperature



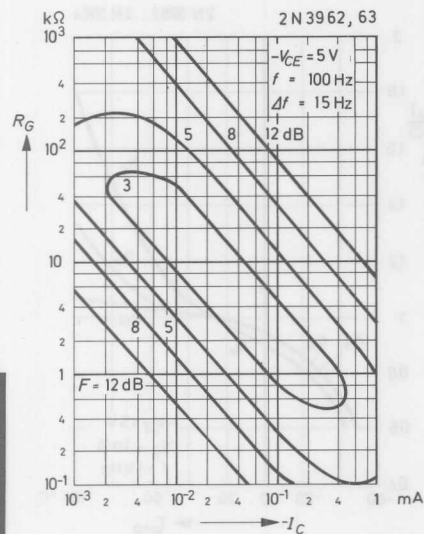
Contours of constant
gain bandwidth product



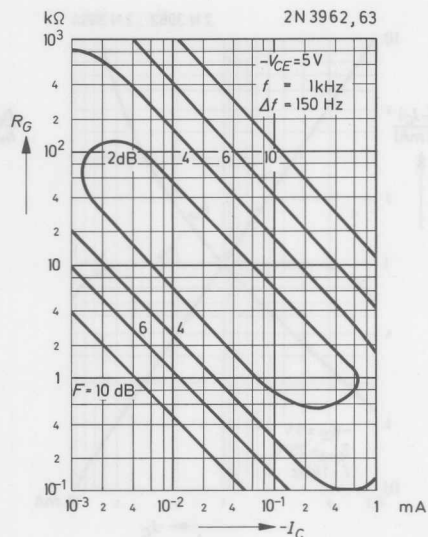
Contours of constant
gain bandwidth product



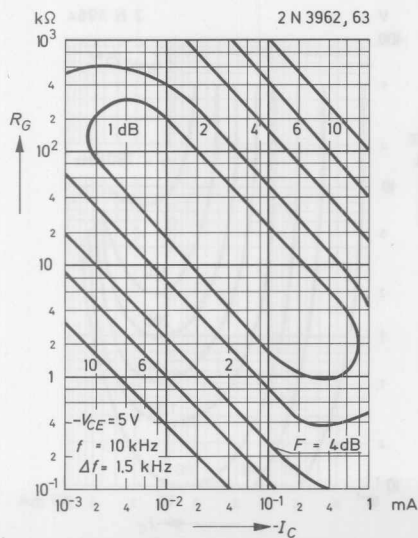
Contours of constant narrow band noise figure



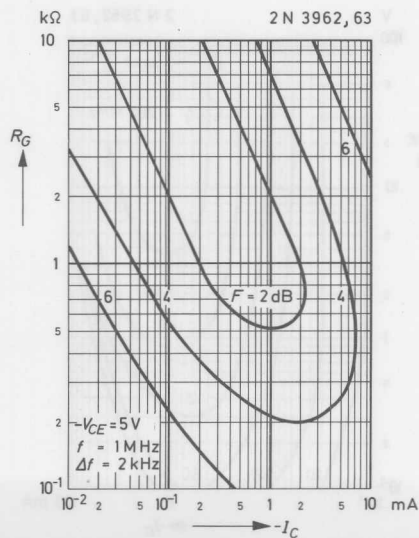
Contours of constant narrow band noise figure



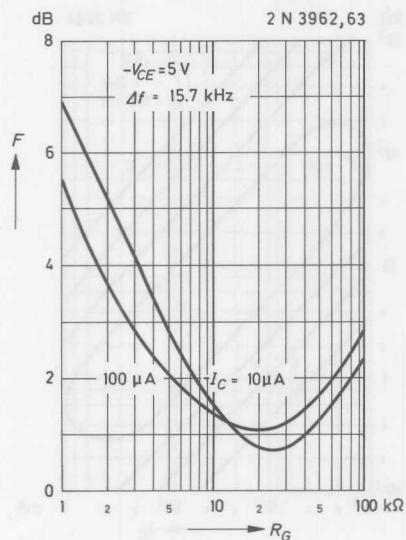
Contours of constant narrow band noise figure



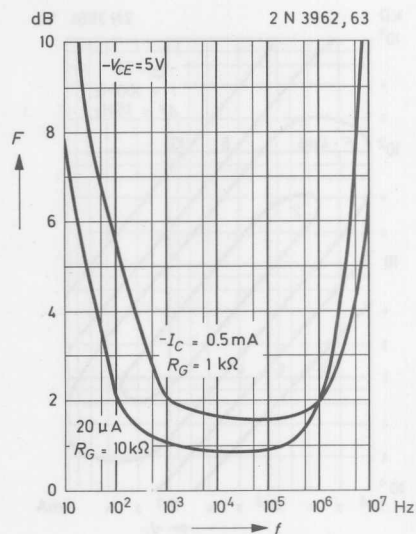
Contours of constant narrow band noise figure



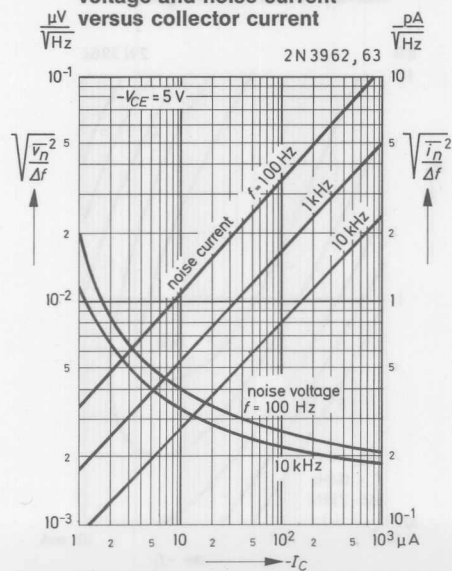
Wide band noise figure
versus generator resistance



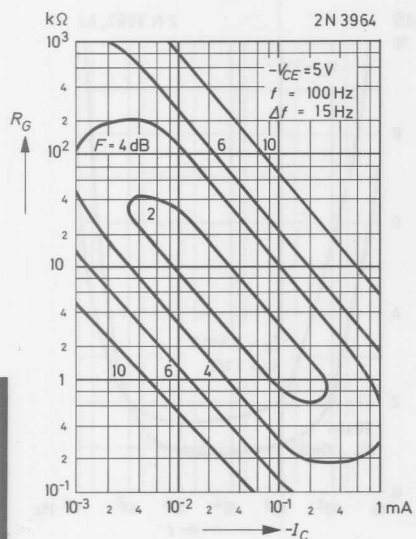
Noise figure
versus frequency



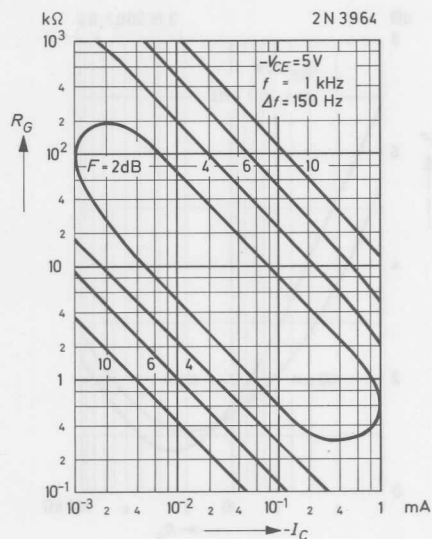
Equivalent input noise
voltage and noise current
versus collector current



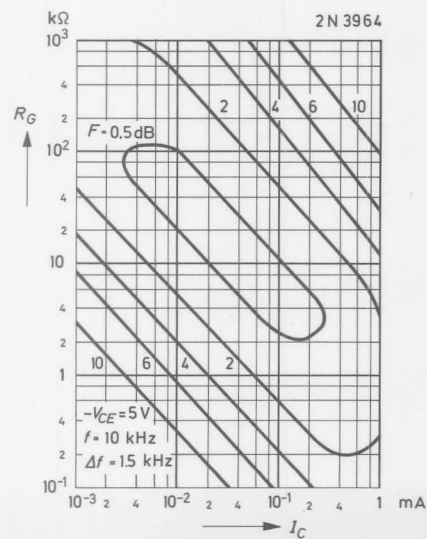
Contours of constant narrow band noise figure



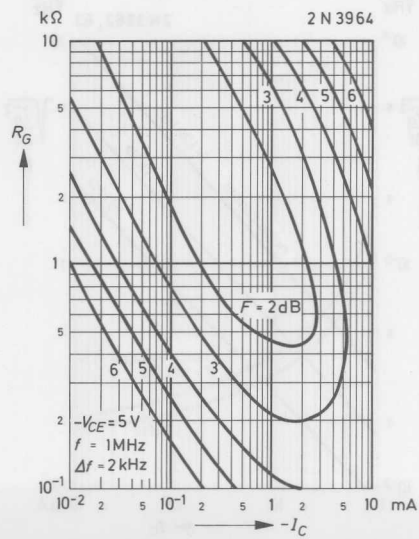
Contours of constant narrow band noise figure



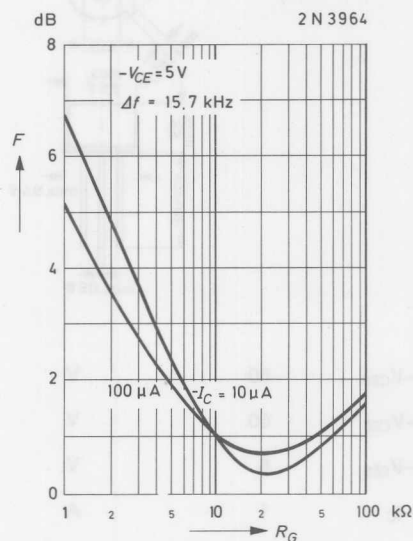
Contours of constant narrow band noise figure



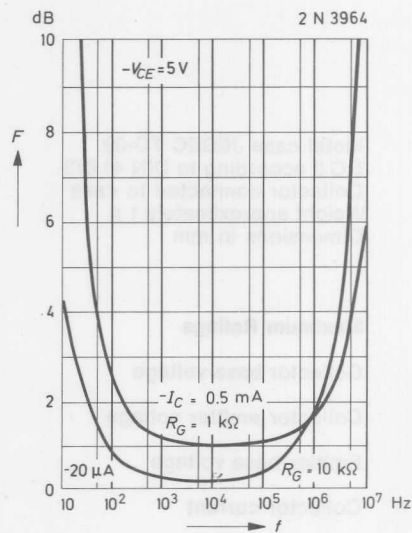
Contours of constant narrow band noise figure



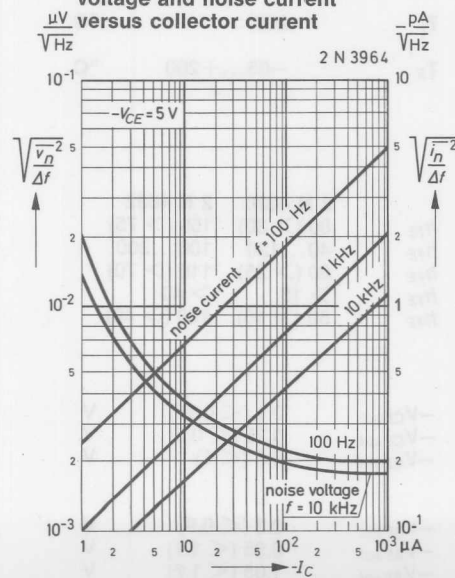
Wide band noise figure
versus generator resistance



Noise figure
versus frequency



Equivalent input noise
voltage and noise current
versus collector current

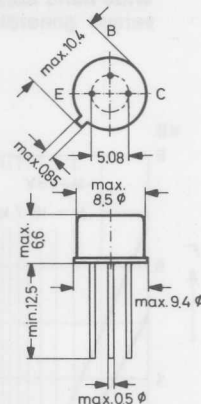


2 N 4030, 2 N 4032

PNP Silicon Epitaxial Planar Transistors

for switching and amplifier applications from DC to RF

Metal case JEDEC TO-39
5 C 3 according to DIN 41873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	$-V_{CB0}$	60	V
Collector emitter voltage	$-V_{CE0}$	60	V
Emitter base voltage	$-V_{EB0}$	5	V
Collector current	$-I_C$	1	A
Power dissipation at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 25^\circ\text{C}$	P_{tot}	4	W
Junction temperature	T_j	200	$^\circ\text{C}$
Storage temperature range	T_S	$-65 \dots +200$	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain

	2 N 4030	2 N 4032
at $-V_{CE} = 5\text{ V}$, $-I_C = 100\text{ }\mu\text{A}$	h_{FE} 80 (> 30)	150 (> 75)
at $-V_{CE} = 5\text{ V}$, $-I_C = 100\text{ mA}$	h_{FE} 40 ... 120	100 ... 300
at $-V_{CE} = 5\text{ V}$, $-I_C = 0.5\text{ A}$	h_{FE} 60 (> 25)	110 (> 70)
at $-V_{CE} = 5\text{ V}$, $-I_C = 1\text{ mA}$	h_{FE} > 15	> 40
at $-V_{CE} = 5\text{ V}$, $-I_C = 100\text{ mA}$, $T_j = -55^\circ\text{C}$	h_{FE} 50 (> 15)	100 (> 40)

Collector saturation voltage

at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$	$-V_{CE sat}$ 0.1 (< 0.15)	V
at $-I_C = 500\text{ mA}$, $-I_B = 50\text{ mA}$	$-V_{CE sat}$ 0.25 (< 0.5)	V
at $-I_C = 1\text{ A}$, $-I_B = 100\text{ mA}$	$-V_{CE sat}$ 0.5 (< 1)	V

Base saturation voltage

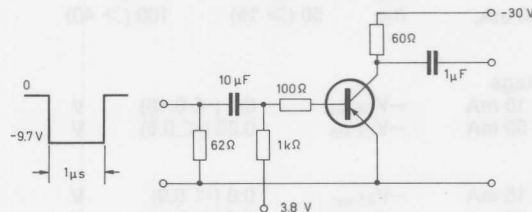
at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$	$-V_{BE sat}$ 0.8 (< 0.9)	V
at $-I_C = 500\text{ mA}$, $-I_B = 50\text{ mA}$	$-V_{BE sat}$ 0.95 (< 1.1)	V
at $-I_C = 1\text{ A}$, $-I_B = 100\text{ mA}$	$-V_{BE sat}$ 1.05 (< 1.2)	V

Collector cutoff current at $-V_{CB} = 50 \text{ V}$	$-I_{CB0}$	0.2 (< 50)	nA
at $-V_{CB} = 50 \text{ V}$, $T_j = 150^\circ\text{C}$	$-I_{CB0}$	0.2 (< 50)	μA
Emitter cutoff current at $-V_{EB} = 5 \text{ V}$	$-I_{EB0}$	< 10	μA
Collector base breakdown voltage at $-I_C = 10 \mu\text{A}$	$-V_{(BR)CB0}$	> 60	V
Collector emitter breakdown voltage at $-I_C = 10 \text{ mA}$	$-V_{(BR)CEO}$	> 60	V
Emitter base breakdown voltage at $-I_E = 10 \mu\text{A}$	$-V_{(BR)EB0}$	> 5	V
Gain bandwidth product at $-V_{CE} = 10 \text{ V}$, $-I_C = 50 \text{ mA}$, $f = 100 \text{ MHz}$	f_T	150 (> 100)	MHz
Collector base capacitance at $-V_{CB0} = 10 \text{ V}$	C_{CB0}	15 (< 20)	pF
Emitter base capacitance at $-V_{EB0} = 0.5 \text{ V}$	C_{EB0}	75 (< 110)	pF
Thermal resistance Junction to ambient air	R_{thA}	< 220	$^\circ\text{C/W}$
Junction to case	R_{thC}	< 44	$^\circ\text{C/W}$

Curves and characteristics of types BC 160 and BC 161 are valid analogously for types 2 N 4030 and 2 N 4032.

Switching Times

Turn-on time at $-I_C = 500 \text{ mA}$, $-I_{B1} = 50 \text{ mA}$	t_{on}	27 (< 100)	ns
Storage time at $-I_C = 500 \text{ mA}$, $-I_{B1} = 50 \text{ mA}$, $I_{B2} = 50 \text{ mA}$	t_s	160 (< 350)	ns
Fall time at $-I_C = 500 \text{ mA}$, $-I_{B1} = 50 \text{ mA}$, $I_{B2} = 50 \text{ mA}$	t_f	23 (< 50)	ns



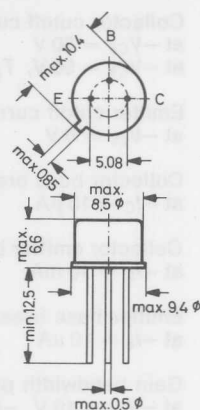
Test Circuit for Switching Times

2 N 4030, 2 N 4032

PNP Silicon Epitaxial Planar Transistors

for switching and amplifier applications from DC to RF

Metal case JEDEC TO-39
5 C 3 according to DIN 41873
Collector connected to case
Weight approximately 1 g
Dimensions in mm



Maximum Ratings

Collector base voltage	$-V_{CB0}$	80	V
Collector emitter voltage	$-V_{CE0}$	80	V
Emitter base voltage	$-V_{EB0}$	5	V
Collector current	$-I_C$	1	A
Power dissipation			
at $T_{amb} = 25^\circ\text{C}$	P_{tot}	0.8	W
at $T_C = 25^\circ\text{C}$	P_{tot}	4	W
Junction temperature	T_j	200	$^\circ\text{C}$
Storage temperature range	T_S	$-65 \dots +200$	$^\circ\text{C}$

Characteristics at $T_j = 25^\circ\text{C}$

DC current gain		2 N 4031	2 N 4033
at $-V_{CE} = 5\text{ V}$, $-I_C = 100\text{ }\mu\text{A}$	h_{FE}	80 (> 30)	150 (> 75)
at $-V_{CE} = 5\text{ V}$, $-I_C = 100\text{ mA}$	h_{FE}	40...120	100...300
at $-V_{CE} = 5\text{ V}$, $-I_C = 0.5\text{ A}$	h_{FE}	60 (> 25)	110 (> 70)
at $-V_{CE} = 5\text{ V}$, $-I_C = 1\text{ A}$	h_{FE}	> 15	> 40
at $-V_{CE} = 5\text{ V}$, $-I_C = 100\text{ mA}$, $T_j = -55^\circ\text{C}$	h_{FE}	50 (> 15)	100 (> 40)

Collector saturation voltage			
at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$	$-V_{CE\text{ sat}}$	0.1 (< 0.15)	V
at $-I_C = 500\text{ mA}$, $-I_B = 50\text{ mA}$	$-V_{CE\text{ sat}}$	0.25 (< 0.5)	V

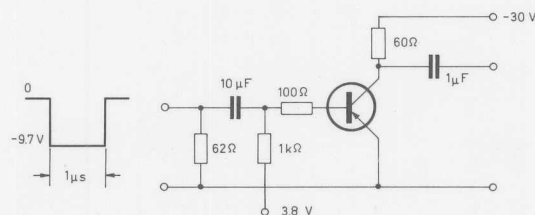
Base saturation voltage			
at $-I_C = 150\text{ mA}$, $-I_B = 15\text{ mA}$	$-V_{BE\text{ sat}}$	0.8 (< 0.9)	V
at $-I_C = 500\text{ mA}$, $-I_B = 50\text{ mA}$	$-V_{BE\text{ sat}}$	0.95 (< 1.1)	V

Collector cutoff current at $-V_{CB} = 50$ V at $-V_{CB} = 50$ V, $T_j = 150$ °C	$-I_{CB0}$ $-I_{CB0}$	0.2 (< 50) 0.2 (< 50)	nA μ A
Emitter cutoff current at $-V_{EB} = 5$ V	$-I_{EB0}$	< 10	μ A
Collector base breakdown voltage at $-I_C = 10$ μ A	$-V_{(BR)CB0}$	> 80	V
Collector emitter breakdown voltage at $-I_C = 10$ mA	$-V_{(BR)CE0}$	> 80	V
Emitter base breakdown voltage at $-I_E = 10$ μ A	$-V_{(BR)EB0}$	> 5	V
Gain bandwidth product at $-V_{CE} = 10$ V, $-I_C = 50$ mA, $f = 100$ MHz	f_T	150 (> 100)	MHz
Collector base capacitance at $-V_{CB0} = 10$ V	C_{CB0}	15 (< 20)	pF
Emitter base capacitance at $-V_{EB0} = 0.5$ V	C_{EB0}	75 (< 110)	pF
Thermal resistance Junction to ambient air Junction to case	R_{thA} R_{thC}	< 220 < 44	°C/W °C/W

Curves and characteristics of types BC 160 and BC 161 are valid analogously for types 2 N 4031 and 2 N 4033.

Switching Times

Turn-on time at $-I_C = 500$ mA, $-I_{B1} = 50$ mA	t_{on}	27 (< 100)	ns
Storage time at $-I_C = 500$ mA, $-I_{B1} = 50$ mA, $I_{B2} = 50$ mA	t_s	160 (< 350)	ns
Fall time at $-I_C = 500$ mA, $-I_{B1} = 50$ mA, $I_{B2} = 50$ mA	t_f	23 (< 50)	ns



Test Circuit for Switching Times

Collector output current		
$I_C - V_{CE} = 0.5 \text{ V}$		
$I_C - V_{CE} = 50 \text{ V}, T = 125^\circ\text{C}$		
Emitter output current		
$I_E - V_{BE} = 3 \text{ V}$		
Collector input breakdown voltage		
$I_C - V_{CE} = 10 \mu\text{A}$		
Collector - emitter breakdown voltage		
$I_E - V_{BE} = 10 \mu\text{A}$		
Emitter base breakdown voltage		
$I_E - V_{BE} = 10 \mu\text{A}$		
Gain bandwidth product		
$f_T - V_{CE} = 10 \text{ V}, I_C = 50 \text{ mA}, f = 100 \text{ MHz}$		
Collector base capacitance		
$C_{cb} - V_{CE} = 10 \text{ V}$		
Emitter base capacitance		
$C_{eb} - V_{BE} = 0.5 \text{ V}$		
Thermal resistance		
Junction to ambient R_{JA}		
Junction to case R_{JC}		
Curves and characteristics of types 2N 4001 and 2N 4002 are valid only for types 2N 4001 and 2N 4002.		

Switching Times

Turn-on time	
$t_{on} - I_C = 50 \text{ mA}, I_E = 50 \text{ mA}$	
Storage time	
$t_{st} - I_C = 50 \text{ mA}, I_E = 50 \text{ mA}, I_B = 50 \text{ mA}$	
Fall time	
$t_{f} - I_C = 50 \text{ mA}, I_E = 50 \text{ mA}, I_B = 50 \text{ mA}$	



Test Circuit for Switching Times

PNP Silicon Epitaxial Planar Transistor
with extremely small feedback capacitance, designed for base-grounded
RF amplifiers in the range of 100 MHz



Flattop case - JEDEC TO-18
TO-18 compatible
The case is impervious to light
Weight approximately 0.15 g
Dimensions in mm

Maximum Ratings			
Collector base voltage	$-V_{CB}$	30	V
Collector emitter voltage	$-V_{CE}$	30	V
Emitter base voltage	$-V_{EB}$	4	V
Collector current	$-I_C$	30	mA
Base current	$-I_B$	4	mA

Power dissipation at $T_{amb} = 25^\circ\text{C}$	250	mW
Storage temperature range	$-55 \dots +150$	$^\circ\text{C}$

PNP Silicon High Frequency Transistors

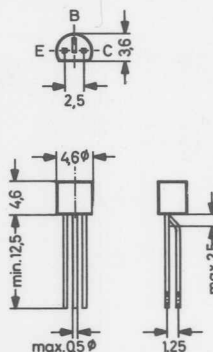
Characteristics at $T_{amb} = 25^\circ\text{C}$			
DC current gain			
at $-V_{CE} = 10\text{ V}, -I_C = 1\text{ mA}$	β_{DC}	45	
at $-V_{CE} = 10\text{ V}, -I_C = 4\text{ mA}$	β_{DC}	20 (25 ... 100)	
Base emitter voltage	$-V_{BE}$	0.75	V
at $-V_{CE} = 10\text{ V}, -I_C = 4\text{ mA}$			
Collector emitter breakdown voltage	$-V_{BEC}$	> 30	V
at $-I_C = 10\text{ mA}$			
Emitter base breakdown voltage	$-V_{EBB}$	> 4	V
at $-I_E = 10\text{ mA}$			
Collector cutoff current	$-I_{CO}$	< 50	nA
at $-V_{CE} = 30\text{ V}$			
Thermal resistance	R_{th}	< 450	$^\circ\text{C/W}$
function to ambient air			
Notes: 1. Voids provided that leads are kept at ambient temperature at a distance of 2 mm from case.			

BF 324

PNP Silicon Epitaxial Planar Transistor

with extremely small feedback capacitance, designed for base-grounded FM RF amplifiers in the range of 100 MHz

Plastic case \approx JEDEC TO-92
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm



Maximum Ratings

Collector base voltage	$-V_{CB0}$	30	V
Collector emitter voltage	$-V_{CE0}$	30	V
Emitter base voltage	$-V_{EB0}$	4	V
Collector current	$-I_C$	25	mA
Base current	$-I_B$	5	mA
Power dissipation at $T_{amb} = 45^\circ\text{C}$	P_{tot}	250 ¹	mW
Junction temperature	T_j	150	$^\circ\text{C}$
Storage temperature range	T_s	$-55 \dots +150$	$^\circ\text{C}$

Characteristics at $T_{amb} = 25^\circ\text{C}$

DC current gain			
at $-V_{CE} = 10\text{ V}, -I_C = 1\text{ mA}$	h_{FE}	45	
at $-V_{CE} = 10\text{ V}, -I_C = 4\text{ mA}$	h_{FE}	50 (25 ... 160)	
Base emitter voltage	$-V_{BE}$	0.76	V
at $-V_{CE} = 10\text{ V}, -I_C = 4\text{ mA}$			
Collector emitter breakdown voltage	$-V_{(BR)CE0}$	> 30	V
at $-I_C = 10\text{ mA}$			
Emitter base breakdown voltage	$-V_{(BR)EB0}$	> 4	V
at $-I_E = 10\text{ }\mu\text{A}$			
Collector cutoff current	$-I_{CB0}$	< 50	nA
at $-V_{CB} = 30\text{ V}$			
Thermal resistance			
Junction to ambient air	R_{thA}	< 420 ¹	$^\circ\text{C/W}$

¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

Gain bandwidth product at $f = 100$ MHz

at $-V_{CE} = 10$ V, $-I_C = 1$ mA

at $-V_{CE} = 10$ V, $-I_C = 4$ mA

at $-V_{CE} = 10$ V, $-I_C = 8$ mA

f_T 350 MHz

f_T 450 MHz

f_T 440 MHz

Feedback capacitance

at $-V_{CB} = 10$ V, $V_{BE} = 0$, $f = 1$ MHz

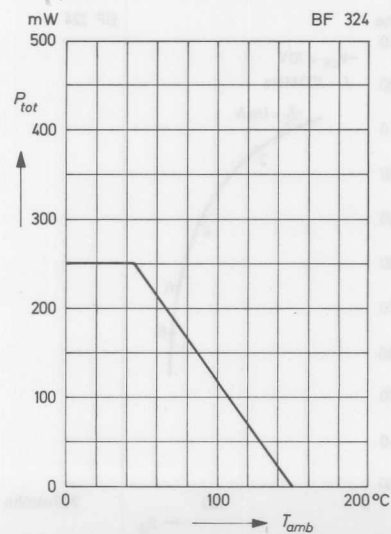
C_{rb} 0.1 pF

Noise figure at $-V_{CE} = 10$ V,

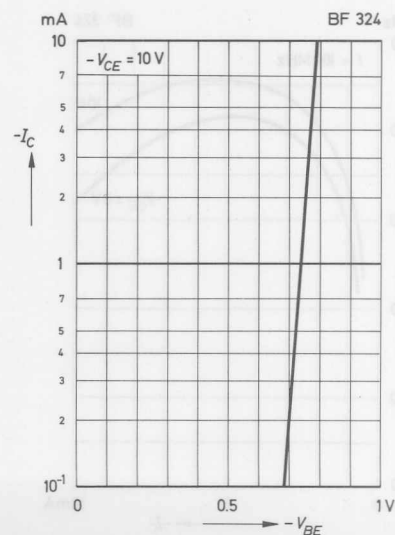
$-I_C = 2$ mA, $f = 100$ MHz, $R_G = 60 \Omega$

F 3 dB

**Admissible power dissipation
versus ambient temperature**
(see note on previous page)

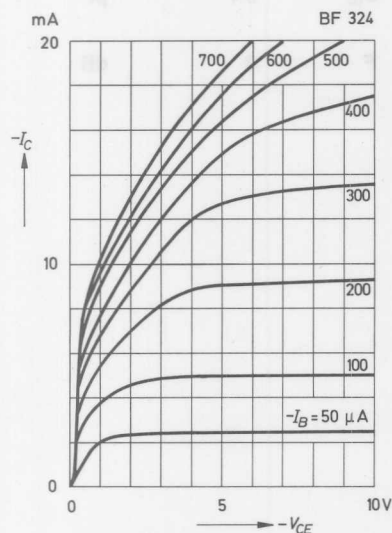


**Collector current versus
base emitter voltage**

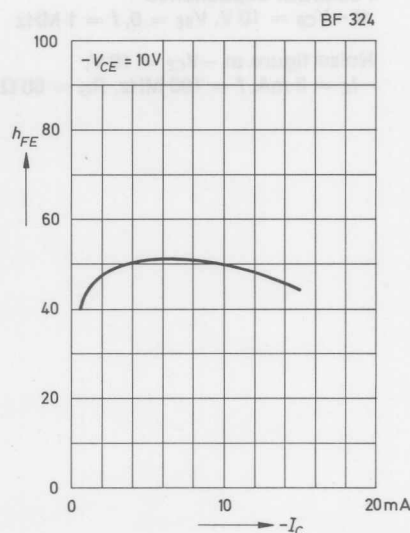


BF 324

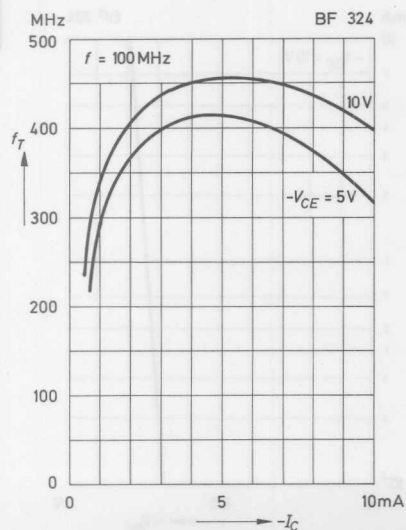
Common emitter collector characteristics



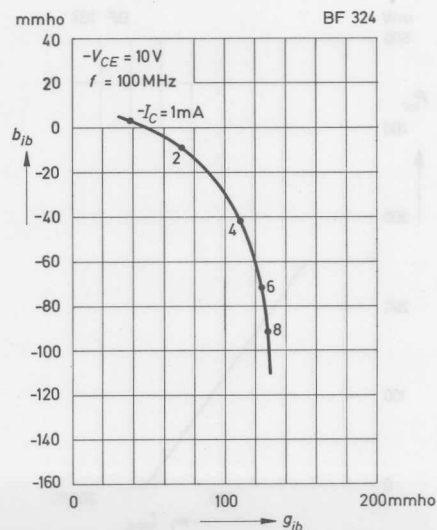
DC current gain versus collector current

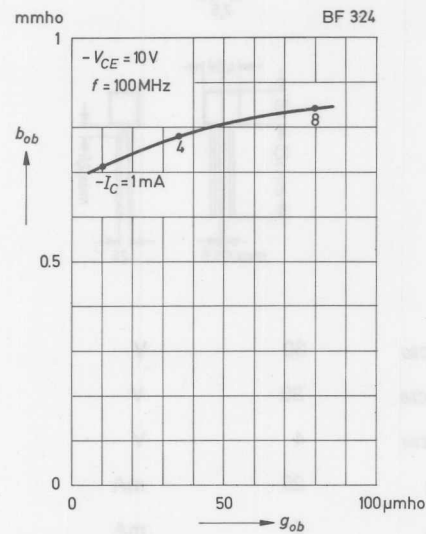
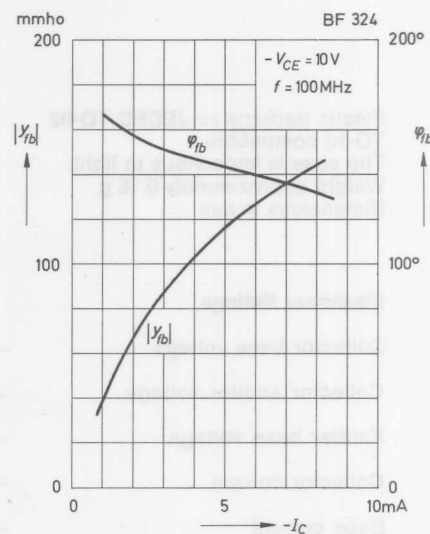


Gain bandwidth product versus collector current

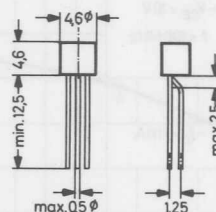
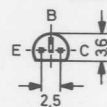


Input admittance characteristic



Output admittance
characteristicForward transconductance
versus collector current

PNP Silicon Epitaxial Planar VHF Transistor for base-grounded VHF amplifiers and mixers



Plastic package \approx JEDEC TO-92
TO-18 compatible
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

Maximum Ratings

Collector base voltage	$-V_{CB0}$	30	V
Collector emitter voltage	$-V_{CE0}$	30	V
Emitter base voltage	$-V_{EB0}$	4	V
Collector current	$-I_C$	25	mA
Base current	$-I_B$	5	mA
Power dissipation at $T_{amb} = 45^\circ\text{C}$	P_{tot}	250 ¹⁾	mW
Junction temperature	T_j	150	$^\circ\text{C}$
Storage temperature range	T_s	$-55 \dots +150$	$^\circ\text{C}$

Characteristics at $T_{amb} = 25^\circ\text{C}$

DC current gain			
at $-V_{CE} = 10\text{ V}$, $-I_C = 1\text{ mA}$	h_{FE}	45	
at $-V_{CE} = 10\text{ V}$, $-I_C = 4\text{ mA}$	h_{FE}	50 (25 ... 260)	
Base emitter voltage	$-V_{BE}$	0.76	V
at $-V_{CE} = 10\text{ V}$, $-I_C = 4\text{ mA}$			
Collector emitter breakdown voltage	$-V_{(BR) CE0}$	> 30	V
at $-I_C = 10\text{ mA}$			
Emitter base breakdown voltage	$-V_{(BR) EB0}$	> 4	V
at $-I_E = 10\text{ }\mu\text{A}$			
Collector cutoff current	$-I_{CB0}$	< 50	nA
at $-V_{CB} = 30\text{ V}$	R_{thA}	< 420 ¹⁾	$^\circ\text{C/W}$
Thermal resistance			
Junction to ambient air			

¹⁾ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

Gain bandwidth product

at $-V_{CE} = 10 \text{ V}$, $-I_C = 1 \text{ mA}$ f_T 300 MHzat $-V_{CE} = 10 \text{ V}$, $-I_C = 4 \text{ mA}$ f_T 500 MHz

Feedback capacitance

at $-V_{CE} = 10 \text{ V}$, $I_C = 0$, $f = 1 \text{ MHz}$

common emitter

 $-C_{12e}$ 0.65 pF

common base

 $-C_{12b}$ 0.3 pFNoise figure at $-V_{CE} = 10 \text{ V}$, $-I_C = 2 \text{ mA}$, $f = 100 \text{ MHz}$, $R_G = 60 \Omega$ F 3 dB

Forward transconductance

at $-V_{CE} = 10 \text{ V}$, $-I_C = 1 \text{ mA}$, $f = 100 \text{ MHz}$ Y_{21b} > 33 mmho

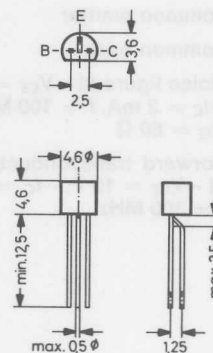
BF 450, BF 451

PNP Silicon Epitaxial Planar Transistors

designed for emitter-grounded AM and FM IF amplifier stages in which the negative pole of the supply voltage is grounded.

The BF 450 is designed for stages with AGC, and the BF 451 is designed for stages without AGC.

Plastic case \approx JEDEC TO-92
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm



Maximum Ratings

Collector base voltage	$-V_{CB0}$	40	V
Collector emitter voltage	$-V_{CE0}$	40	V
Emitter base voltage	$-V_{EB0}$	4	V
Collector current	$-I_C$	25	mA
Base current	$-I_B$	5	mA
Power dissipation at $T_{amb} < 60^\circ\text{C}$	P_{tot}	150 ¹	mW
Junction temperature	T_j	150	$^\circ\text{C}$
Storage temperature range	T_S	$-55 \dots +150$	$^\circ\text{C}$

Characteristics at $T_{amb} = 25^\circ\text{C}$

DC current gain at $-V_{CE} = 10\text{ V}$, $-I_C = 1\text{ mA}$	BF 450 BF 451	h_{FE} h_{FE}	> 60 > 30	
Collector base breakdown voltage at $-I_C = 10\text{ }\mu\text{A}$		$-V_{(BR)CB0}$	> 40	V
Collector emitter breakdown voltage at $-I_C = 2\text{ mA}$		$-V_{(BR)CE0}$	> 40	V
Thermal resistance Junction to ambient air		R_{thA}	< 600 ¹	$^\circ\text{C/W}$

¹ Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

BF 450, BF 451

Collector cutoff current
at $-V_{CB} = 30 \text{ V}$

$-I_{CB0} < 50 \text{ nA}$

Gain bandwidth product
at $-V_{CE} = 10 \text{ V}$, $-I_C = 1 \text{ mA}$, $f = 100 \text{ MHz}$

$f_T = 325 \text{ MHz}$

Feedback capacitance
at $-V_{CE} = 10 \text{ V}$, $-I_C = 1 \text{ mA}$, $f = 1 \text{ MHz}$

$-C_{re} = 0.35 \text{ pF}$

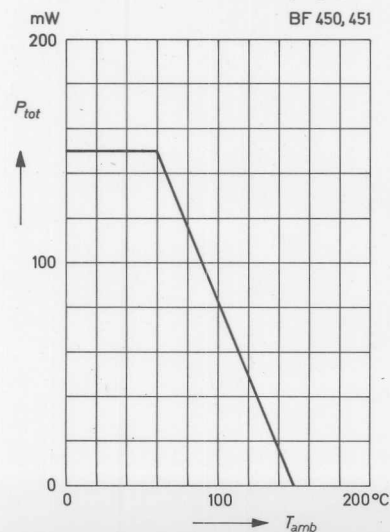
Real part of output admittance
at $-V_{CE} = 10 \text{ V}$, $-I_C = 1 \text{ mA}$, $f = 0.5 \text{ MHz}$

$g_{oe} < 8 \text{ } \mu\text{mho}$

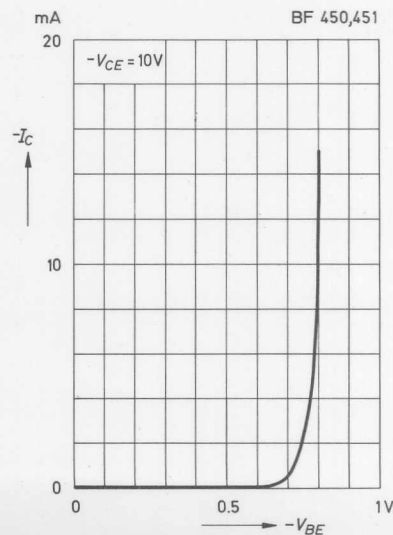
Noise figure at $-V_{CE} = 10 \text{ V}$,
 $-I_C = 1 \text{ mA}$, $f = 100 \text{ kHz}$, $R_G = 300 \text{ } \Omega$

$F = 2 \text{ dB}$

Admissible power dissipation
versus ambient temperature
(see note on previous page)

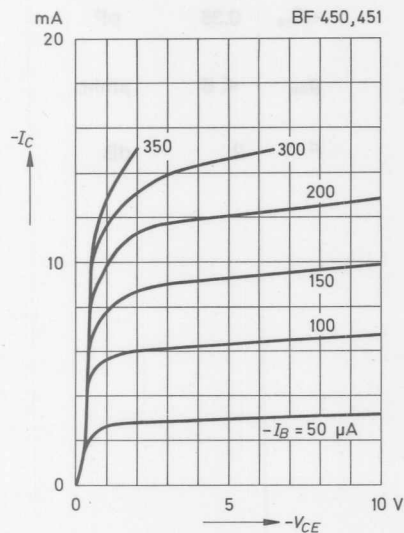


Collector current versus
base emitter voltage

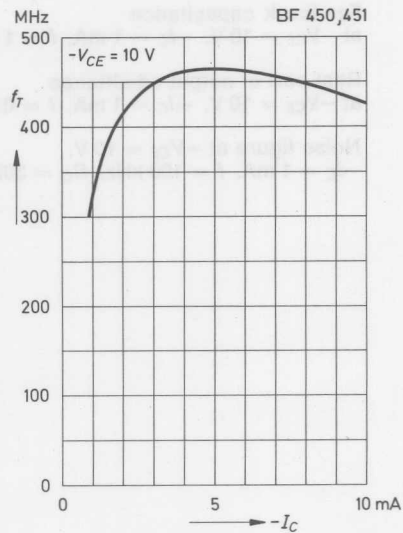


BF 450, BF 451

Common emitter collector characteristics



Gain bandwidth product versus collector current





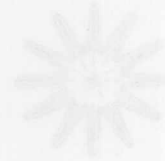


Item No. 101 for 10-12 case

Item No. 102 for 13-15 case

Material: black varnished plywood
Weight approx. 2 g

Technical reference to case No. 101 - 48-01/2



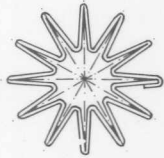
Dimensions in mm

Accessories

Accessories

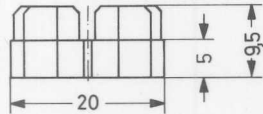
Heat sink KS 1 for TO-39 case

fitting for all transistors in TO-39 case



Material: black varnished bronze beryllium
Weight approx. 2 g

Thermal resistance in free air:
 $R_{thS} = 46 \text{ }^{\circ}\text{C/W}$



Dimensions in mm

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General Information

NPN Silicon Transistors

NPN Silicon High Frequency Transistors

PNP Silicon Transistors

PNP Silicon High Frequency Transistors

Accessories